# Rhodora

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CONTENTS:



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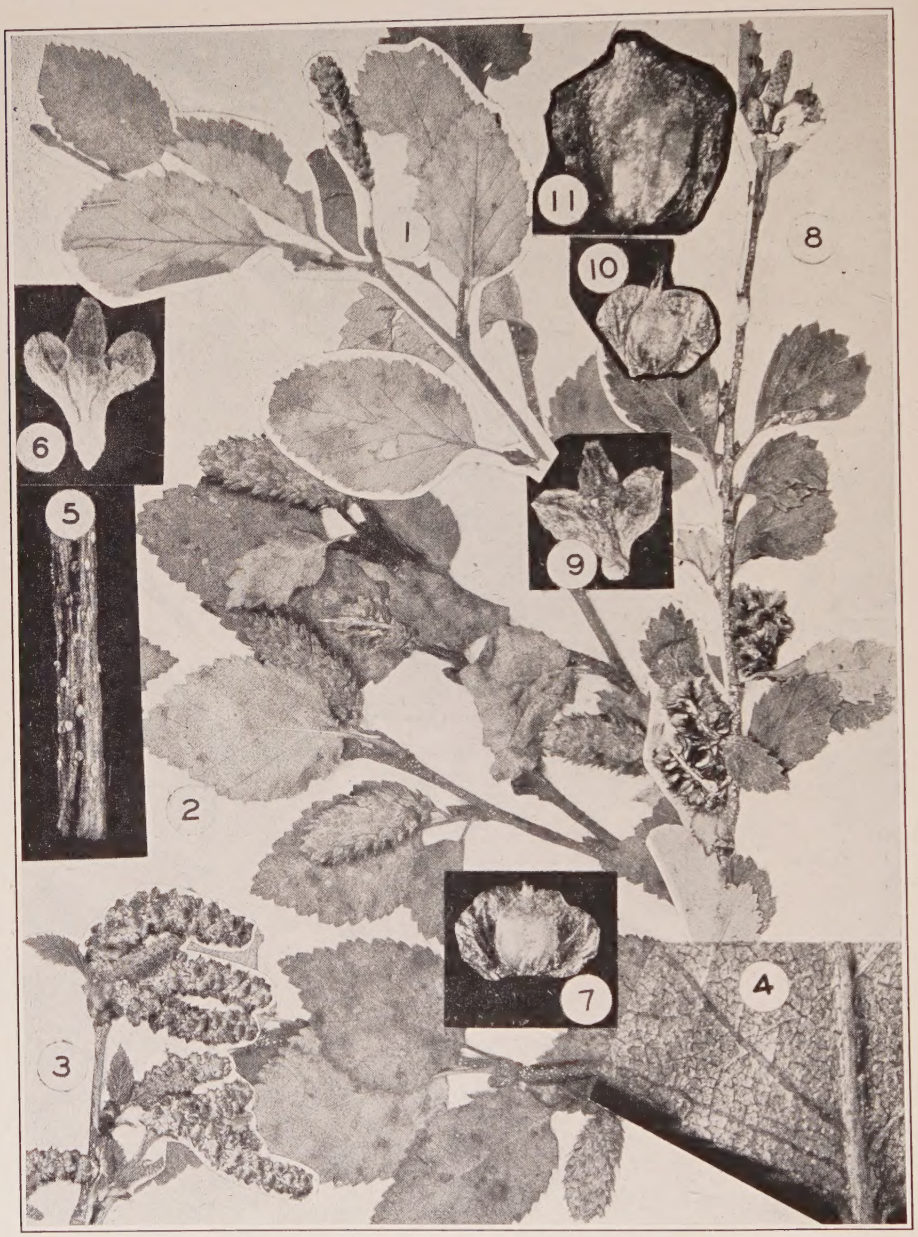


*Photo. B. G. Schubert*

BETULA MINOR: FIG. 1, portion of TYPE, × 1; FIG. 2, fruiting branch, × 1; FIG 3, staminate aments, × 1; FIG. 4, lower surface of leaf, × 5; FIG. 5, branchlet, × 10; FIG. 6, fruiting bract, × 4; FIG. 7, samara, × 4.

B. MICROPHYLLA: FIG. 8, fruiting branch (probably of ISOTYPE), × 1; FIG. 9, fruiting bract, × 4; FIG. 10, samara, × 4.

B. ALBA, var. TORTUOSA: FIG. 11, samara, × 4.

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# ON THE DESCRIPTIVE METHOD OF LINNAEUS*

H. K. Svenson

(Plates 990 and 991)

"There are as many various forms in the world as there are individuals, and no two are found which are perfectly alike; therefore Nature may be said to display herself in variation . . . The older naturalists saw that there was order in nature which consisted in the similitude of things, but they were unable to combine the similar and to separate the dissimilar. They saw the chain of nature but could not forge the links. The links of this chain . . . the Creator has thrown into the world without order; thus it is of wisdom to inquire into these, and to search out their similitudes and dissimilarities and to combine those which should be combined; whence at length results the *Ordo naturalis*, which presents the mundane things mutually combined so that an affinity of these appears, which extending itself throughout the whole reign of Nature is the ultimate end of the systematic order". From Introductio ad Ordines Naturales Linnaei, Mss. Fabricius (1792), ed. Schuster, 1926.

*Species Plantarum*, published in 1753 by Carl Linnaeus (1707–1778),[1] has been chosen as the starting point of modern botanical nomenclature, and as such it represents perhaps the most important work in systematic botany. But various interpretations show that there is not a clear understanding of the method by which the book was written, and of its purpose. Consequently there have been many unnecessary changes of names in recent times, due primarily to a lack of understanding of Linnaean procedure. The subject is therefore of vital importance in the development of a stabilized nomenclature, a goal toward which all systematic botanists are bent, at least nominally. Spring (Ueber

* Brooklyn Botanic Garden Contribution no. 103.

[1] In formal Latin this becomes "Carolus Linnaeus"; the form "Linné", obviously of French origin, was later in common use by Linnaeus.

die naturhistorischen Begriffe von Gattung, Art, und Abart und über die Ursachen der Abartungen in den organischen Reichen. Leipzig. 1838, pp. 14–24) gives a good general account of pre-Linnaean nomenclature. Of Linnaeus (p. 18) he says: "What he differed in from all his predecessors, and what will always remain as his greatest accomplishment is the *sequence* with which he built up a system of nature, and the precision and clarity with which he formulated the rules and principles of the subject. In this respect he has been the law-giver for all succeeding time."

By Linnaeus *Species Plantarum* was looked upon as a compendium without descriptions, except in some ambiguous[2] cases, and the number of species *described* within its covers was relatively few. The names of species go back in general to earlier dates, usually within the fifty to eighty preceding years, and especially to Linnaeus' earlier works. Many names were based upon illustrations. Where there is a description to be found, Linnaeus marks the reference with an asterisk. Binomial nomenclature was not intended by Linnaeus to supersede the polynomial specific name, and Linnaeus when later citing specific names used the binomial no more than he did the polynomial nomenclature. Despite statements in text books the polynomial specific name, especially as developed by Linnaeus[3], was not so cumbersome and could readily be cited by use of dots for the abbreviated portion. No one would want to give up the binomial system of today, but that does not preclude the fact that modern botanical nomenclature lacks some of the flexibility of the Linnaean polynomial.

Much of the misunderstanding of the Linnaean method is due to a lack of comprehension of definitions[4]. The term "method"

[2] No definite explanation of the word "ambagibus" is given by Linnaeus, but its application is apparent once the usage of the Linnaean term "descriptio" has been recognized. On page 18 of the preface to *Flora Zeylanica* (1747), Linnaeus mentions both *obscure* and *dubious* plants. *Obscure* plants are defined as those of which the fructification is but little, or insufficiently, known; in *dubious* plants the fructification is lacking. These terms apparently were not carried over into *Species Plantarum*.

[3] Composed of not more than twelve words, differentiating the species from all others of the genus according to rules laid down in *Critica Botanica* (1737). Differentiae were called "essential" when only a single idea was emphasized, as *Claytonia foliis linearibus*, or synoptic when (as in large genera) a series of ideas was necessary.

[4] Linnaeus was a rapid worker, and at times careless in details, especially as to bibliographic references. Many of these minor errors were corrected in the second edition of *Species Plantarum* (1763), but some of the mistakes ascribed to him were rather the mistakes of recent interpreters. Such, for example, is the idea that *Scirpus geniculatus* was based on the plant with rounded spikelets, or that *Dioscorea sativa*

applies here to a formal arrangement of material especially dealing with phrase-names and synonymy, such as, for example, Gronovius employed when he followed the Linnaean "method" in his *Flora Virginica* (1739). The term "specific name" applies only to the phrase-name[5]. This has been more clearly recognized in recent years, and the term "specific epithet" is sometimes used in place of the Linnaean "trivial name". The term "description" applies to an actual, more or less detailed, description of the plant.[6] Short comments following a discussion of a species in *Species Plantarum* should be classed as "observations". Examples of the *descriptio* are given in *Philosophia Botanica*, that of *Passiflora foetida* being considered by Linnaeus as ideal. The

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is an oriental species. The latter is unknown in the Old World, as the species of the genus are recognized in modern literature, and nearly all of the Linnaean references point to a New World species, which the habitat "in Indiis" does not preclude. The editing of some of Linnaeus' works was done hurriedly and sometimes by students. In a letter to Beck ((Hulth no. 785; May 29, 1753) he says of *Species Plantarum:* "Salvius demanded a prompt recension. I asked a student to make it. Salvius improved it." Kalm, writing on Oct. 15, 1752 (Hulth no. 1614) urged Linnaeus to write a "Synonymia Plantarum", offering "to take it upon myself to edit half the book, though I should have to sit night and day to write; only so that the book might come out".

The exacting and often discouraging task of writing *Species Plantarum* was carried out in the years 1749–1752, and its progress may be followed in letters to Beck (edited by J. M. Hulth, 1909) from which excerpts are quoted in translation. No. 671, Oct. 6, 1749: "I am beginning to drop *Species Plantarum* from my mind; since autumn I have not had time to look at it. I have worked along to the *Polyandria*, but it will be impossible with a whole year's steady work to finish them. I feel like leaving what is done as an inventory after me, so that posterity might see that I could have done it if I had had the time and energy. Why should I work myself to death and lose contact with the world? What does one gain? One does not become wise till the end". No. 728, Nov. 12, 1751: "I am working on *Species Plantarum* and have come to *Icosandria*". No. 738, Dec. 1751: "I am like a setting hen on its eggs, hatching out species, but the hatching time is much longer, so that I have got only to the *Diadelphia*, though I work night and day". No. 741, March 6, 1752: "Now I have reached to the *Syngenesia* with my *Species*, and think I shall rest for a few days". No. 752, June 5, 1752: "I have finished my *Species*".

[5] It is strange that a person as well versed as DeCandolle (Théorie élémentaire de la Botanique 1813, p. 223) should have so misunderstood the situation: "Linné . . . propose . . . que le nom d'un être naturel serait composé de deux mots: le premier, qu'il appela le nom *générique*, serait commun à toutes les espèces d'un genre; par example, *Rosa*, *Trifolium;* le second, qu'il nomma *spécifique*, devait être propre a chaque espèce d'un genre."

[6] cf. Richter, Codex Botanicus Linnaeanus, p. xi. (1840): "Signum* in Spec. pl. adhibitum, teste praefatione significat *descriptionem* in aliquo citato opere dari . . . Hoc signo nonnulli, qui leviter inspexerant *Species Plantarum*, decepti sunt, ut crederent opus praecipuum et prae ceteris fidum eo indicare, id quod nunquam in mentem venit Linnaeo." [The asterisk, used in *Species Plantarum*, signifies (according to the introduction) that a description is given in the work cited. . . . By this sign, some who have casually examined *Species Plantarum* have mistakenly believed that a work more important than the others was indicated by him, something which had never entered Linnaeus' mind].

term "diagnosis" does not occur in Linnaean works except in connection with the generic name; it has been adopted by some as a substitute for the Linnaean specific phrase-name, but in modern usage it may lack entirely the differential character of the Linnaean specific phrase-name. There is nothing to support the statement of some botanists that a new specific phrase-name ("diagnosis") was based upon herbarium specimens which Linnaeus had before him. The new specific name was, on the other hand, a most important feature in the Linnaean method, by which old phrase-names were brought into conformity with the other specific names in the genus, in whatever new work was under way by Linnaeus or his collaborators.[7] Such new specific names, quite obviously, do not constitute a quotation from some previous work, as do the majority of Linnaean specific [phrase] names in *Species Plantarum*. The Linnaean specific name was not only a definition of the species, but essentially an all-inclusive key to the species, corresponding to the distinctions in dichotomous keys of our current manuals. A new specific name represented either a new species or the reformation of an older specific name; in the latter case the old name became a synonym taking its place at the head of the list. Such synonyms were *names*, in general comprehensive and accumulative, i. e. including various figures, descriptions and specimens, and were not ordinarily, as in modern usage, based on single specimens. The Claytonian reference in Gronovius' *Flora Virginica* was not a true synonym; it was a brief description of the Clayton specimen, now being assigned to a proper specific name under the Linnaean method. These descriptive notes, accompanying specimens, which Clayton wrote in English, were translated into Latin by Gronovius and appended to his treatment of the individual species. Misunderstandings as to the nature of Gronovius' synonyms have led, in the author's opinion, to many unnecessary changes in the names of American timber trees, and this subject is therefore one of great practical importance. This procedure will be discussed in detail under the heading "The Species".

[7] Cf. *Fl. Suecica* (1745), introd.: "The majority of the specific [phrase] names are new. I have sometimes changed specific names, not because I considered the previous ones as erroneous, but because these new ones are clearer and easier to understand. When more species have been observed and their outstanding characteristics detected, and more apt terms struck, it will be necessary sometimes to emend the differentiae, though previously they may have been very good."

Whatever thread is followed into the tangled skein of comment and literature on the *Species Plantarum*, general conclusions or points of view are reached that would also have been attained by some other angle of approach. The term "method" is a comprehensive one, but, as I have stated, it has a certain connotation in respect to the Linnaean works. I have found it expedient to treat the subject both from a historical point of view and as an elaboration of the important elements of the method. Perhaps the most outstanding asset of Linnaeus was "common sense". In the reforms of botanical nomenclature which will come within the next few decades, I believe the method of Linnaeus will play an important part. Since so much has been written about the artificial as compared with the natural system of botany, I have included at the end a resumé of the Linnaean natural system, as recorded by his students, Fabricius and Giseke. It will be seen that many things that the present-day botanist thinks of as recent developments, such as the reticulate nature of evolution, and graphic presentations of the relationship between families and genera, had already been elaborated by Linnaeus and his students. It is strange that no botanist to whom I have shown Giseke's account in the course of the last ten years (during which I have from time to time been occupied with this paper) had ever seen, or more than glanced at the work.

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As early as the spring of 1733, Linnaeus (then twenty-six years old and recently returned from his Lapland journey) had preliminary drafts of *Species Plantarum* and a general outline of the botanical works, that he was to publish from time to time. To Cronhjelm[8], then chancellor at Lund, he wrote:

"I have worked with the greatest diligence on a new System, based on a wholly new principle. Having assembled a herbarium of some thousand plants, I have examined as many species as possible, with dissection of three to four thousand flowers. From this work has come six or seven small volumes, including *Bibliographia Botanica*, which shows at a glance what each botanist has written, and an account of all previous botanical systems; *Philosophia Botanica*, which sets up rules, with examples, showing

[8] cf. T. M. Fries, Bref och Skrivvelser af och till Carl von Linné, vol. 1, pt. 5: letter no. 1233. Vol. 1 (1907–1922), containing letters to and from correspondents in Sweden, consists of 8 parts but reaches alphabetically only through Laxmann. There are 1670 letters in this volume of which parts 7 and 8 are by J. M. Hulth. He also edited the second volume, which contains correspondence with foreign botanists, but reaches only from Adanson through Brünnich.

the reasons for many botanical errors, which are now becoming aggravated; *Homonyma Botanica*, dealing with all the names of plants which botanists have postulated (in large measure groundless), and showing that of 2000 generic names scarcely 200 are correct, and of some 1000 species names hardly 100—since botanists have not understood varieties, which they hold to be distinct species; *Species Plantarum*, in which I intend to show that though botanists pride themselves on having 20,000 plant species[9], there are not more than 8000 when varieties have been placed under their proper species. Each species is to be recognized at first glance without the presence of description or figure".[10]

This new method was not perfected until 1753, with the publication of *Species Plantarum*. The species contained in this work were derived from five sources:

1. Publications dealing with plants which Linnaeus had seen growing under natural conditions, as *Flora Suecica* and *Flora Lapponica*.
2. Publications based on cultivated plants which Linnaeus had seen in a living state, as *Hortus Cliffortianus* and *Hortus Upsaliensis*.
3. Publications based on herbarium specimens, as Gronovius' *Flora Virginica* and Linnaeus' *Flora Zeylanica*.
4. Specimens in Linnaeus' own herbarium and in the herbaria of other botanists.
5. Figures, such as those of Plukenet, and of Cornut's *Canadensium Plantarum Historia* (1635), and Sloan's *History of Jamaica*, of which Linnaeus had seen no herbarium specimens.[11]

[9] Compare the notation in the introduction to *Species Plantarum;* "I have judged with satisfactory calculation that the number of species in the entire world is much less than is commonly believed, and that it hardly reaches 10,000". Considering this figure, it must be kept in mind that Linnaeus' conception of species in general was a much broader one than that of the present day. According to A. P. DeCandolle (Théorie élémentaire de Botanique 1813) Linnaeus had 7540 species in 1260 genera in the second edition of *Species Plantarum* (1763). On page 23 DeCandolle says: "There are 30,000 species of plants known in the world; 40,000 if we include all that are unnamed in our collections; and there will probably be more than 60,000 when all the continents are well investigated."

[10] In the preface to *Critica Botanica*, written from Cliffort's Museum in 1737, Linnaeus states: "As to specific names I have mentioned hardly any examples, since there are but few that are meritorious, and to very few botanists (even at this date, when we take pride in a flourishing botanical science) is it certain which plants are varieties and which are species; therefore in *Hortus Cliffortianus*, which is soon to be published through the liberality of my generous patron, I have worked hard to reduce varieties to their species, and to provide the species with specific names."

[11] Of the nineteenth century botanists, C. B. Clarke had perhaps the best understanding of Linnaean procedure. In Journ. Linn. Soc. Bot. **30**: 299. 1894, he writes: "A 'species' in his Sp. Pl. is made up of 4 (or fewer) parts, viz. (a) the citations of his predecessors; (b) the citations of pictures; (c) the diagnosis of Linnaeus himself; (d) the authentic examples in Linnaeus's herbarium. Perhaps the most important of these four is the first: Linnaeus meant invariably that his species should be the sp.

Here is bound up the most significant feature of *Species Plantarum*, a recension of previously published work [of comparatively recent authors], in which species are for the first time[12] differentiated. Previous works such as Bauhin's *Pinax* had treated various "kinds" of plants as units of equal rank. A corollary to this idea, as Lindman and E. L. Greene have already pointed out, is that varieties were first distinguished from species by Linnaeus.

In *Species Plantarum*, the species are treated from a wholly practical point of view. It was not meant to be otherwise. As a philosophical treatise on the species problem it offers little or nothing; the work is an artificial[13] system based on the number of pistils and stamens, which, as Linnaeus was wise enough to see, could not in his day be replaced by a natural system satisfactory for the practical identification of plants.

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From a philosophical point of view Linnaeus was clearly a disciple of Ray, and through Ray, of Morison. It may be added that the technical approach of *Species Plantarum*, the *methodus*, is modeled also on the work of Ray. Linnaeus' philosophical concept of species follows quite a different trend from that of *Species Plantarum* and is based mostly on experimental evidence; Ray's work forms the basis of the *Critica Botanica* and the *Philo-*

auct. of his day; Linnaeus generally draws his diagnosis by directly copying from his predecessors, only altering it so far as to make it include his authentic specimens."

[12] This does not include such fragmentary forerunners as Linnaeus' *Amoenitates Academicae* and *Flora Suecica*, the treatments of which were usually incorporated directly into *Species Plantarum*.

[13] This was only one of a number of artificial systems current at the time (cf. the fructification system of Hermann, the calyx system of Magnol, and the corolla system of Rivinus. These various systems formed the taxonomy of DeCandolle (1813), p. 24: "After having devised successfully in many groups the individual names of the plant world, we arrive at a sure means of identifying those which interest us: it is this part of plant study which I designate by the name *taxonomie botanique*." Practically all parts of the plant were used in various schemes. Thus, as Usteri (Magazin für die Botanik 1: 15–48. 1787, under the title *Nachtraege und Fortsetzung der Linneischen Sammlung botanischer Systeme*) says (p. 16): "To proceed along the way that had been shown, and to make it the more passable, was the effort of every worthy botanist. But the nature of the thing was such that they did not work together, but went along different ways; this differentiation was, however, only superficial—for fundamentally they all worked toward the same goal—and in order to attain this goal, all the various ways had to be used, for by one way alone it could not be achieved. These various ways were the fundamental parts upon which they built their divisions, and such a foundation every part of the plant could give. There are systems which are based on all observed parts of the plant, at least in contemplation, and the greater number of them have already appeared."

*sophia Botanica*, as these works deal with the fundamental problem of species. The "constancy" of species as stated in Linnaeus' earlier works was an answer to the "transmutation" ideas of the naturalists who came before Redi, and whose influence still lingered on into the eighteenth century.[14] In rejecting ideas of direct transmutation of species, which had been based on faulty experimental evidence, Linnaeus was abreast of, or ahead of his time—as a matter of fact no one up to the present time has directly perceived the transmutation of one species into another.

It is quite fitting to quote here Chapter xxi of Ray's *Historia Plantarum* (1704), in translation:

"Plants which derive their origin from the same seed, and again propagate themselves in sowing, we may consider as belonging to a single species; for those variations of leaves, colors of roots, taste, or even colors of fruits and seeds, we conclude to be neither characters nor indices of what is called specific diversity. But this quality, however constant it may be as a sign of species, is not perpetual or infallible. Experiments have been made to try to show that some seeds degenerate and produce plants, though rarely, of diverse species from the mother . . . Galen once sowed *Triticum* and *Hordeum*, and having selected out all of the seeds which were admixed, he could with certainty tell whether *Lolium* and *Aegilops* had arisen from a 'mutation' of these, or whether each had its own appropriate seed. For, if by chance one of these made its appearance among pure seeds, as *Lolium* frequently does among *Triticum*, or the vigorous *Aegilops* among *Hordeum*, the aggressor was evident . . . These experiments, from various workers both ancient and modern, appear very similar to some of our own; partly because through error the cause was not recognized, partly because they owe their origin to philosophers or the overcredulous or to the less circumspect in tracing a phenomenon to its causes—for these reasons we hold these experiments as uncertain and suspicious. Thus we think that the father of Galen was deceived in the rationalizing of phenomena. For it does not follow that because *Lolium* is often found in *Triticum* that the *Triticum* has changed into *Lolium:* the *Lolium* might well have arisen from *Lolium* seed from a previous year. And so as to the *Aegilops:* I myself have observed that in a certain field where pure *Triticum* had been sowed, that the potent *Aegilops* had lain fallow after a whole year. Then the *Aegilops* owes its appearance to its own seeds and not to those of *Triticum*". And on p. 40: "Thus as to plants of specific conformity: there is certainty that they came from the seed of the same plant, whether as species or individual. For those which differ as species preserve their species in perpetuity, and one does not arise from the seed of the other, or vice versa."

This problem and the associated problem of the continuity of species was discussed by Hornborg under the supervision of Linnaeus in volume 5 of the *Amoenitates Academicae* (1757):

[14] This situation is well described by Bateson, Problems of Genetics, p. 3, 1913.

"The ancients thought that many plants were produced from seeds sown at the creation of the earth, when they observed various plants springing forth from soil recently dug up. Some thought that pines, when burned, turned into oak; others thought that fungi, mosses and other minute plants, as well as minute animals, originated by spontaneous generation, or by putrefaction or fermentation. This hypothesis endured until the time of Harvey, who dared to assert that all life came from the egg, and was similar to the mother . . . Nor was Redi able to obtain animalcules in putrid meat unless insects had access to lay their eggs". And in part x: "Turning our attention to plants we see the trunk of the tree extending into branches. We may compare this type of multiplication with that of *Taenia*, where any single articulation may produce a new individual . . . Or we may compare it with *Sertularia* . . . Similarly to be compared are the roots of grasses and cereals which have numerous joints creeping below the surface of the ground; . . . these plants often form gemmules which reproduce the entire plant. What mortal has ever seen a branch of a tree, of herb, of grass, or any other vegetation, however much it may be dissected, ever change its nature, or produce other plants or species? *Ligustrum*, *Tilia*, or any other tree may be repeatedly trimmed by the topiarist, as is the custom in our gardens; but no mortal has ever seen new branches of any different species regenerate . . . Nature is a law of God; constant, ever constant, is this law of nature, that organisms give rise to similar ones, and that ferocious eagles do not produce peaceful doves". Cf. also one of Linnaeus' letters to Beck (Hulth no. 657, written in 1746): "It is apparent that polyps lead a vegetable life. They increase by seeds as do plants; they increase by stems or roots as do *Salices*. Good God! the animal and vegetable kingdoms approach each other so much that we shall soon have to have a new set of surveyors to make the division lines".

These introductory statements on the constancy of species, as seen by Linnaeus in his earlier years, may be brought to a close with the related philosophical arguments on the nature of varieties, propounded by Linnaeus in section 271 of *Critica Botanica* (1731):

"All species number their origin first from the hand of the Omnipotent Creator: for species having been created, the Author of Nature has imposed the eternal law of generation and multiplication within the species itself. It is conceded that the external appearance often deviates, but there is never a metamorphosis from one species into another. Hence there is today a double differentiation among plants; one a diversity produced by the wise hand of the Omnipotent, the other of sportive Nature, showing variety in the external crust. If the garden is sowed with a thousand diverse seeds, the diligent care of the gardener aids in the production of monstrosities; and after some years it will contain six thousand varieties, which the ordinary botanist calls species. I therefore distinguish species of the Omnipotent Creator or true species from the monstrous varieties of the Horticulturist . . . These monstrosities luxuriate in variegations, multiplications, doublings, proliferations, and fascinate the eyes of the beholders with their protean variation, as long as the gardeners make daily sacrifices for their idols. If they are neglected, these ghosts of variability fall into ruin."

## The Genus

The *Genus* was elaborated in Linnaeus' *Genera Plantarum* (1737)[15]. As I have pointed out, it may be considered the oldest of the botanical groups. Genera of Bauhin contained, more or less indiscriminately, items which were placed by Linnaeus under their proper species and varieties. Generic names frequently came from Tournefort or even older writers, but some were based on collections of Gronovius and the American plants obtained by Kalm. Thus in *Amoenitates Academicae*, generally accepted as the work of Linnaeus[16], his student Chenon (**3:** 1–27. 1751) states under the title "Nova Plantarum Genera": "Since Professor Kalm, lately returned from Canada, has detected many new genera . . . (p. 3), with these brief remarks I proceed to propose as new those genera which are established by Kalm's plants, together with his notes which were communicated to me." These new genera are: *Lechea*, *Sarothra*, *Alethris*, *Helonias*, *Dirca*, *Kalmia*, *Gaultheria*, and *Polymnia*. These genera were incorporated without further change into the first edition of *Species Plantarum*, an example (*Lechea major*), being as follows:

> 2. Lechea foliis ovati-lanceolatis, floribus lateralibus vagis.
> Gen. nov. 1074. f. 4*.
> Habitat in Canada aridis.

The *genus* and *species*, under the Linnaean method, were the stable and fundamental categories, i. e. they were "natural" units (Philosophia Botanica, section 162). Superior groups, the *class* and *order*, were to be considered as both natural and artificial; the lower group, the *variety*, was in general to be considered the product of cultural conditions. The *character*, or definition of a genus (Phil. Bot. sect. 186) was of three grades, depending upon the amplification:

[15] This publication, dealing with the larger, relatively simpler group, i. e. the genus, was a forerunner of *Species Plantarum*. In par. xxvii: "Species heic nullas trado; quas diagnoscere facillimum erit Botanico ex datis Characteribus; qui has desiderat ex meis principiis, eas partim in *Flora Lapponica* quaeret, sed maximum numerum ex *Horto Cliffortiano* petat". . . [I treat no species here; these can be easily distinguished by the botanist from the given characters; whoever wishes these species, based on my principles, will find them partly in *Flora Lapponica*, but for the greater part in *Hortus Cliffortianus*.]

[16] B. D. Jackson, Authorship in the Amoenitates Academicae, Journ. Bot. 51: 101–103. 1913: "He [Linnaeus] (p. 102) plainly looked upon these productions as entirely his own."

(1) The *natural character* (189) was the basis of all systems, and included all possible *notae* of the genus, both macroscopic and microscopic (191), except for such common *structurae naturalissimae* as only idiots (59) bothered to describe. "The *natural character* is absolutely fundamental for the recognition of plants and cannot be neglected; it is, however a work of infinite labor before characters are evolved which accord with all the species of the genus. The experienced botanist alone (193) can best make the *natural character*, which should be drawn up from an accurate description of the *primae speciei*[17], with which all other species of the genus should be carefully compared, in order to exclude all discordance. No character is infallible until it has been applied to all the species of the genus. Difference in structure of the fructification (92) is the basis of genera.[18]

(2) The *factitious character* distinguishes a genus from all other genera of the same artificial order (188). The few *notae* (which are taken from the *natural character*), suffice to distinguish genera. The *factitious character*, or *diagnosis* (188)[19], as Linnaeus states, was defined by Ray (188): "the characters of a genus are not to be multiplied except from necessity, and not more are to be assembled than are necessary for definitely determining the genus." *Factitious characters* (190) have been proposed by those who introduce *notae* in an artificial method, by which they are able to distinguish genera placed within the same order; thus they were used by Ray, Tournefort, Rivinus, and many previous authors.

(3) The *essential character* (187) distinguishes the genus by a single peculiar or unusual character (such as the nectariferous

[17] This is the only reference I have found in Linnaean literature to the "type method", It does not necessarily refer to the first species published under the genus in *Species Plantarum*.

[18] Every *nota characteristica* depends on the *number*, *figure*, *proportion* and *place* of the differentiating parts of the fructification (86). These are: calyx (including glumes of grasses, spathes, bracts of aments, involucrum of *Umbelliferae*, etc.), corolla (including petals and nectaries), stamens, pistils, pericarp (capsules, legumes, pomes, etc.) seeds, and receptacle. These various parts (167) of the fructification number 38. When multiplied by 4 (number, figure, situs, and proportion), 152 combinations are possible; by recombination of the 38 parts, there are 5776 possibilities, far more than sufficient for the number of genera.

[19] This is the only instance where I have seen this term used by Linnaeus. It has been misapplied to the Linnaean specific name. At the present time it is used much in the manner of the *factitious character* of Linnaeus for a brief condensation of the description of a genus or of a species, but without the differential feature which was fundamental to the Linnaean specific name.

pores at the base of the petals in *Ranunculus*, or the capitate fruit of *Magnolia* with seeds pendent by threads (105). It is the easiest way to know plants, and is used to distinguish genera of close affinity in a natural order by one or two *notae*. It is selected from the *natural character*. "If the essential characters of all the genera could be detected the recognition of plants would be easy, but whoever thinks that he can know botany from the *essential character* to the neglect of the natural character deceives himself. In the detection of new genera, without the *natural character* there would always be doubt (191)[20]."

The foregoing three characters of the genus—which have been quoted from *Philosophia Botanica*—show different human aims. The *natural character* represents the complete description of the genus, upon which the natural system could be based. This type is the basis of *Genera Plantarum*. The *factitious character* was a selection of characteristics, such as would suffice for separation of genera in an artificial system or key. It has been in use from time immemorial. The *character essentialis* represents the simplest method of recognition. This triple method of working out the genus, it will be seen, was also a prototype for the Linnaean treatment of the species.[21]

Genera were described in *Genera Plantarum*, and in conformity with the conciseness characteristic of Linnaeus, the genera were not again treated in *Species Plantarum*. The preface to *Genera Plantarum* contains a number of statements of importance in the Linnaean method, though the idea of fixity of species expressed in this early work was considerably modified in later years. The most important ideas (from our point of view) are perhaps the following:

[20] The question whether a generic character (in the modern sense) can delimit a genus *per se* arises constantly. The *essential character* of Linnaeus (such as thread-pendent seeds of *Magnolia*) was founded only on unusual structures.

[21] The factitious, essential, and natural characters were briefly discussed by Thornton, Elements of Botany (1812) p. 83–85, without much understanding:

1. The *factitious character* is employed in tables to discriminate all the *genera* falling under each particular Class and Order (*Vide* our British Flora).

2. The *essential generic character* comprehends all the distinctions requisite to discriminate any *genus* from all the other genera in the world . . . the multitude of genera is great, amounting . . . to considerably more than 2000.

3. The *natural generic character* is a careful description of all parts of the fructification, as the *Calyx, Corolla, Stamina, Pistilla, Pericarp* and *Seed;* and this was what Linnaeus particularly prided himself in . . .

"Names of plants are generic and specific (in case there is more than one species in the genus). There are as many species as there are diverse forms produced by the Infinite Being in the beginning; these forms have produced descendents, but always similar, according to the known laws of generation, so that the species which we now have are no more than there were in the beginning. Therefore species are as many as there are diverse forms or structures of plants occurring today, excepting those in which habitat or some other cause has produced differentiation (i. e., *varieties*). Genera (section 6), therefore, are as many as there are common attributes next [in rank] to those of distinct species, such as were created in the beginning: this is confirmed by revelation, experiment and observation. Hence *all genera and species are natural.* We must attentively and assiduously, by observation, inquire into the limits of genera. These limits may be difficult to determine, but *confusion in genera means confusion in everything.* I inculcate on all true botanists, if stability in this art is to be desired, that *all genera and species are natural;* unless this principle is assumed there can be no soundness in the art.

Natural genera (section 10) being assumed, there are two requirements for maintaining them sound: that only true species and no others be placed in the genus; that each true genus be circumscribed by limits and terms which we call the *generic character.* No authority except dissection in the herbarium should be acknowledged.

Icones (section 13) are not recommended for determination of genera: before the development of the alphabet it was necessary for things to be expressed in pictures where speech was not possible. Upon written words a genus can be more firmly based, and it is not always practicable to publish a picture. In a given genus the shape and number of parts differs in the various species, and the position and proportion of the parts must be established with care. This cannot be done in an illustration unless figures of all species are given. Thus for fifty different species, there should be that number of illustrations. Therefore, to omit the differential characters and describe only similarities is far less work and easier to understand".[22]

As Spring (op. cit.) states (1838, p. 88) most genera in practice are artificial, inasmuch as they do not actually represent the next entity above the species, but only the relative goal of easier classification. But all should [theoretically] be natural, since (1) they have natural entities [i. e., species] as their base, and are built up on the same principles as are species; and (2) genera must (of necessity) be set up if there is a similarity which affects the whole plant and not merely the individual parts, and if a disconformity (Bildungsabschnitt) or change in nature is suspected. The existence of genera in Nature is apparent only by induction. Di-

[22] The reader will realize how difficult it is to illustrate a genus pictorially, and that illustrations of genera are almost invariably delineations of individual species. This question was discussed by a nomenclature committee in Journ. Bot. **30**: 242. 1892: "But a picture can never show the special characteristics alone, which raise the genus above the other of its affinity. A genus only gains priority by a verbal diagnosis".

rect proofs of the existence of genera fail us. But this is true also of species and no one doubts that there are natural species. Both are abstractions (p. 89), for the individual alone appears bodily in Nature. That natural genera exist is shown in their unrestricted sense in the speech of various peoples. Everywhere one finds similar species consolidated under a single genus name, but seldom do vernacular names conform to true species (p. 90). Even among uneducated peoples, the pink, the rose, tulip, grass, the owl and the eagle are seen as genera. As natural history rose among the Greeks and Romans, genus names increased accordingly, while species were differentiated only by occasional and changeable names. It is, as a rule, easy to recognize concretely what differentiates and what binds together (p. 96); "but to find the exact point wherein things differ and where they are similar, and to explain the situation in measurable terms, is very difficult."

This question as to whether or not genera are "natural" came up at an early date, and still persists in some form or other.[23]

[23] Cf. the question, "Which in your opinion is the more natural unit among the flowering plants, the genus or the species? (i. e., which of the two more often reflects an actual discontinuity in organic nature) by Anderson in the "Concept of the Genus", Bull. Torrey Club 67: 364. 1940. I believe that I was one of the few who replied that the question was meaningless, for the *genus* and the *species*—at least in Linnaean taxonomy—are both natural by assumption, hence the limits of these entities are represented by discontinuities. As revealed by the answers, the hypothetical question was understood as, "On the basis of *present* (or *past*) *taxonomic usage* is a discontinuity found between genera more frequently than between species?" The difficulty and necessary ambiguity in answering this question becomes apparent from Weatherby's statement in Rhodora 44: 160. 1942, "So long as we have to rely on judgment at all, the accuracy and soundness of any taxonomic category, definition or no definition, will be in direct proportion to the accuracy and soundness of the individuals who apply it".

It was precisely here that Lamarck differed from the Linnaean point of view, to quote from Lamarck, Illustration des Genres, p. xv. 1791 (in translation): "If Linnaeus, instead of attributing genera to Nature, had considered them as assemblages of species approaching one another in most respects, and at the same time of assemblages well detached from one another by artificial limits . . . he would have prescribed laws convenient for guiding the establishment of limits of these assemblages. By these laws he would have prevented and moderated the arbitrariness which exists among nearly all botanical authors, who, without any rule which suits them well, continually are making innovations. Some reunite many genera into one, but more often form several genera from the species of a genus already established, which they distinguish by certain considerations chosen for this genus alone. The essential object in the formation of genera is to diminish the quantity of names to be retained in the memory, a quantity which would be enormous if a simple name were given to each plant . . . Two forces must of necessity be taken into consideration in the establishment of genera, that is to say, in the distribution of separating lines which one chooses for the genera: 1) it is important that genera should not be too numerous in species; 2) genera must not be too much reduced, and they should comprise, as far

Thus, in Ortega's edition of *Philosophia Botanica* (1792), in the "Annotationes, Explanationes, et Supplementa" (p. 410) there is a discussion of the Linnaean precept, "*Omnia Genera et Species naturales esse, confirmant revelata, inventa, observata*". Of this phrase Ortega says:

"That species of plants were created by God at the beginning of the world and do not change into other species, and are therefore *natural*, and that they remain unchanged to the present day no sane person will doubt; the confusion which would arise from the change of one *Species* into another, to the detriment of mankind, would not be allowed by the most provident Maker. And *Genera*, inasmuch as they are composed of *natural species* might also be said to be natural: but that God, all powerful in creation, has made the *Species* of plants with similar marks and characters, so to be distinguished that all of these species fall into certain *Genera*, just as families are diverse from one another, I do not dare to affirm. *A posteriori*, certainly many *Species* are to be observed with so many characters, especially of the fructification, in turn consistent with or different from other *Species*, that they can readily be referred to the same *Genus* in conformity with our art. But on the other hand, there are individual *Species* which could in no way be associated with others to constitute a *Genus*. And the idea of a *Genus*, if I am not mistaken, always involves the idea of several species similar to one another, and

as possible, a certain set number of species". And p. ix: "Linné, wishing apparently to give to genera a consideration which they did not have, pronounced anathema against those who were assured that there were no genera in Nature. He had, without doubt, more ability in supporting his opinion by trenchant decision, and by the pretended axioms and laconic maxims with which he has filled his *Philosophia* and his *Critica Botanica*, than by solid proofs which alone would convince those whom he could not win over by authority; proofs that he always forgot to establish."

The opinion of Asa Gray was still different (Structural Botany, p. 323, 1879): "Constituted as the vegetable and animal kingdoms are, the recognition of genera or groups of kindred species, is as natural an operation of the mind as is the conception of species from the association of like individuals . . . The number of species in a group is immaterial, and in fact is very diverse. A genus may be represented by a single known species, when its peculiarities are equivalent in degree to those which characterize other genera . . . If only one species of Oak were known, the Oak genus would have been as explicitly discerned as it is now that the species amount to three hundred; and better defined, for now there are forms quite intermediate between Oak and Chestnut . . . (p. 324) So that the recognition of genera even more than of species is a matter of judgment, and even of conventional agreement as to how and where a certain genus shall be limited, and what particular association of species shall hold the position of genus".

Linnaeus gave the clever answer to this problem by stating that the genus was "natural", but that the limits could not be determined until all the species of the genus were known. He wisely left the differentiation of genera to a succeeding generation. The real question at hand is whether we wish to have all of our genera "natural", that is bounded by discontinuities, and I think that our answer, as it was with Asa Gray, is "No!" No more disastrous way could be found for destroying the stability of our nomenclature. In large genera only a very few species approach the theoretical boundary line against which the adjacent "unnatural" genera eventually impinge, the point at which there should be "conventional agreement as to how and where a certain genus should be limited". As in many other things, we must formulate here a compromise between the practical and the theoretical.

Linnaeus himself says (Canon 159): 'There are as many genera as there are similar structures of fructification produced by diverse natural *Species*'. The similitude cannot exist unless it is shared by at least two species, despite whatever Linnaeus may have precariously asserted in Canon 203. For of the species which he had considered as solitary, several have proved not to be so, since congeners have been detected in *Dodartia, Hydrophyllum, Corymbium,* and *Gloriosa;* as to the others it is prudent neither to assert or deny what may be their future status . . . We do not wish to raise the nominal question whether plants have really been formed by God into *Natural Genera;* we rather offer the definition of a genus in the judgment of the learned, as follows: 'There are as many genera as the *Natural Species* show different forms of fructification'."

The modern problem of the limits of genera thus had raised itself at an early date. Ortega (op. cit.), in discussing the statement of Linnaeus (Phil. Bot. 160) that "*artificial classes are a substitute for the natural until all the natural classes have been detected, and because many genera are as yet unknown, the limits of classes present the greatest difficulties,*" says that the same, in his judgment is true of the limits of genera. If all plants (cf. Linnaeus, Phil. Bot. 77) show an affinity on either side, then that affinity would increase more and more if all species were detected. And he quotes from Oeder (Fl. Danica, Fasc. 2, introd. p. 12); "If we are really willing to confess, it is not allowed us or ever will be, to know the differences which exist between plants or to set up invariable limits of genera or of superior or inferior groups. Not only may the author of such limits modify these limits from time to time, but others may be led by sufficiently strong arguments to acknowledge these changes".

The younger Linnaeus, in the preface to *Supplementum Plantarum* (1780), was cognizant of some of the difficulties:

"I have tried, as far as possible, to make few new genera; whatever plants could be transferred to some genus already recognized without danger to the character essentialis, I have assigned to the genus, even though there might be only a single character in diagnosing them. In this respect I am in disagreement with many botanists of our time, who seem to be persuaded that *the genus produces the character.* For I have found in my experience, that too numerous genera unnecessarily extend the science, separate affinities, multiply difficulties in distinguishing the genera, and furthermore impede the perception of the character essentialis".

Thus the character or *nota* appeared—and this is true also in modern taxonomy—as a sort of "doctrine of signatures" which revealed to what genus the species was to be allocated. And the variation in human judgment in selection of characters and their

delimitation has produced a sort of fantasy which has its main significance and stabilization in the historical view which is called "usage". To this stabilization the "doctrine of descent" has not added as much as was anticipated in the late nineteenth century; as a matter of fact, by injecting the additional dimension of "time", the evolutionary point of view has sometimes complicated rather than simplified the situation, leading to many tenuous modifications of nomenclature based on theoretical phylogeny.

As A. P. DeCandolle explains it (Théorie de Botanique . . . 187. 1813): "The second rule Linnaeus announces to us in his laconic style in the words *character non facit genus*, that is to say, in order to make a genus it is not sufficient to have any isolated character, taken from the fructification and separating one or many plants from those that resemble it, but it is also necessary that the plants themselves be distinguished from others and approach them in 'l'ensemble de leur végétation'. This sage principle is the veritable touchstone of genera, and should always be in the eyes of the naturalist". Cf. *Critica Botanica*, 169: "Characterem non constituere Genus, sed Genus characterem". [The character does not make the genus, but the genus makes the character].[24] The corollary is the Linnaean statement that the limits of a genus cannot be definitely determined until all the species of the genus are known.

As to any single character alone characterizing a genus, the opinion of Linnaeus was probably much like that of many modern botanists, such as that of Pittier (Contrib. U. S. Nat. Herb. **20,** pt. 2:40. 1917): . . . "the differential characters of the genus (*Lonchocarpus*) are never absolute when taken singly . . . . Every one of these characters, considered separately, will be found to be shared with other more or less related genera,

[24] Cf. the footnote in Ruiz & Pavon, Fl. Peru. Prodr. p. 41: "This genus (Gilibertia) and the preceding (Tovaria) were opposed by Cavanilles because, as he says, they were founded without any criteria. Though there may be only one species in *Tovaria*, he says there is nothing constant in *Tovaria stigmata peltata et septemfida* to be a generic character, since the number of parts of the fructification is *sometimes eight or rarely nine*, as was mentioned in the *Observ.* . . . It might be noted, as Ruiz has added, that there is no genus if there is only one recognized species . . . For it is well known to all that no generic character is well constructed, or at all stable, unless all species of the genus are discovered and recognized. For this principle Linnaeus, 'Botanicorum facile Princeps', set up Canon 193 in his *Philosophia Botanica*, where he says: 'No character is infallible until it has been applied to all the species of the genus.'".

but it is their concurrence upon which the genus *Lonchocarpus* is based". There seems to be such a thing as a generic character *per se* only in the relatively unusual *nota singularis* of Linnaeus.

The most important statements of Linnaeus as regards the Genus are in sections 169 and 170 of *Philosophia Botanica*, and these all tend to emphasize the relatively unstable limits of the genus as compared with the species:

"*Notae characteristicae* which serve for stabilization in a certain genus may be of little value in some other genus. For you know that the character[25] does not constitute the Genus, but the Genus the character; that the character flows from the Genus, and not the Genus from the character; the character is set up, not that the Genus shall be made, but that the Genus shall be known. Therefore the greatest botanical heresy is to set up innumerable spurious genera, to the detriment of botany. A genus is rarely observed in which some part of the fructification[26] is not aberrant. Many *genera ficta* have arisen from species diverse in some part of the fructification: e. g. in *Carduus*, *Euphorbia*, *Hibiscus*, *Ranunculus*, *Gentiana*, *Primula*, *Bidens*, etc. Unless this principle is assumed there will be as many genera as there are species".

Linnaeus has something to say, also, on the opposite side of the question:

"In many genera a *nota singularis*[27] of the fructification will be observed, but if it is not present in all the species of the genus, care must be taken that several genera were not originally included—for example, *Erica* and *Andromeda* were formerly placed in one genus, but the awned anthers are peculiar to *Erica; Aloe* and *Agave* formerly constituted a single genus, but the stamens of *Agave*, inserted on the corolla and not part of the receptacle, distinguish the two genera. The more constant a part of the fructification may be in many species, the more certain it is that a generic character (*nota*) is present [174]. In some genera one part, in other genera another part of the fructification will be found the more constant; but none are absolutely constant. If the flowers are the same, but the fruit differs, all other things being equal, the genera should not be separated [176]".

And in *Critica Botanica* (section 281):

"Generic characters [*notae*] used for [specific] differentiae[28] are absurd. The beginner, when he first starts to examine the fructification, finds so

[25] This term, as I have mentioned, is used in the sense of "generic" description; for the individual "character", in our sense, Linnaeus uses the term "nota".

[26] This Linnaean term includes also the flower.

[27] Based on the number, figure, proportion and site of various parts of the flower and fruit (Phil. Bot. 92) a triple classification is to be derived: *Naturalissimam*, *Differentem*, and *Singularem*, and upon these are based respectively the Natural, Factitious, and Essential Characters of the Genus.

[28] It should be emphasized here that the species within a genus were distinguished and delimited by the *differentiae* which were part of the specific name. This was not done for genera by Linnaeus, the genus being set up merely as a synthesis of species. The limits of genera are, in common experience, more vague and less easily drawn than are

many individual characters [notas singulares], almost infinite, that he believes that no one before him has examined the flowers, and that there are almost as many new genera as there are species; but when several years have passed in such examination, he first finds the essential generic characters, and begins to distinguish them. Then he easily falls into the other extreme, and has doubts in everything."

The following translated quotations from letters of Linnaeus (Hulth 1907–1912) provide a commentary:

No. 545. To Bergius, Dec. 12, 1770. "*Erica* is undoubtedly one of the most difficult of genera. If it is at any time to be worked out, I think the following would be necessary: 1) sufficient *differentiae specificae*, so that the species could be clearly and securely distinguished; 2) *correct descriptions* and *figures;* 3) synonyms, preferably from accurate figures. As far as synonyms are concerned, I think it is better to have a few sure ones, for many figures are uncertain, and when we do get them they are often distorted. To get figures accurately made here, has been and will always be impossible for me.[29] I believe that if you and I should go into partnership, that we would have most of the Ericas. You have seen how difficult, if not impossible it was to evaluate certain synonyms, until a great many species were made known. I could have sworn that your *E. Plukenetii* and mine were the same species if I had not seen both of them."

No. 620. Browallius to Linnaeus, Jan. 24. 1745. "From Kalm's letter I see how your *Peloria* has caused alarm in the ranks; but I really think you should not be troubled too much about it, since if it throws over some of the *principles assumed for setting up genera*, so much to the good. And you well know that you have never thought otherwise than, since genera are the work of man, that man can also be mistaken. But one should especially be careful of the dangerous statement that this species might have been produced after the Creation. Species the

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the limits of individual species. Between many genera,—such as *Aster* and *Erigeron*, *Oldenlandia* and *Houstonia*, or *Rynchospora* and *Dichromena*—the distinctions become merely academic, or indeed invisible. The situation may be compared to the contiguous or separated circles which illustrate the relationship of the orders in Linnaeus' Natural System (see discussion at the end of this paper) and which are graphic illustrations of his statement: "Natura non facit saltus. Plantae omnes utrinque affinitatem monstrant, uti Territorium in Mappa geographica". From a dynamic point of view we may think of genera as broadening concentric circles such as the rings formed by pebbles thrown into water: the initial impact representing the type species of the genus, and the resulting concentric rings the accretion of species through historical usage. Not until such a circle impinges upon other circles is the practical problem of generic limits involved. This problem may be solved by somewhat arbitrarily dividing the few transitional species which occur at the borderline, chiefly according to usage, between the component genera, or of combining the two genera into one. The first method gives us stability of generic nomenclature. The second leads us to eternal instability, in an attempt to complete the "chain of nature" or the "phylogenetic tree". In the flowering plants, at least, our progress does not seem to have been very marked during the past century.

[29] Linnaeus was never able to obtain funds at Upsala or Stockholm for sumptuously illustrated botanical works, such as were published in Holland or England. For further notations on synonymy and illustrations the reader is referred to succeeding sections of this paper.

Creator has determined through [unchanged] *propagation by seeds.* Genera are the first and smallest group of species, and they do no good except to bring simplicity into the study of elementary botany. And things should not seem too strange if a new observation discloses something that goes against previous rules. One must in such cases cling to Newton's rule: *against truths established on the basis of a comprehensive and certain experience, no objections are admissable except those drawn from experience; then first should a doctrine be offered, bounded by these limitations.* The same thing can happen in botany that we have seen in the history of magnetism, electricity, and endless other things".

As a final word on the Genus, I quote from A. P. DeCandolle's "Théorie de Botanique" (1813), p. 260–261, to show how much the understanding of Linnaean method had already gone astray.

"Generic characters vary, according to whether they represent a natural or an artificial order. Linnaeus distinguished two sorts of characters: one, which he called *essential*, stated only what he considered necessary to distinguish a genus from others in the same class; the other, which he called with reason *natural*, contained a short description of all the parts of the fructification. Distinction between these two types of characters was indispensable in an artificial system. One can, in an artificial order, understand very well the essential character of a genus without having the least idea of the real form or of its nature or relationships, which are what one finds in the natural character . . . all that one finds in the natural characters of Linnaeus is implicitly stated in the character of the family and the tribe . . . If a genus has several characters particular to it, one does not fear to use all: thus my generic characters are somewhat longer than the essential characters of Linnaeus, but we avoid also the descriptive or natural characters. The generic characters should be treated in a sequence similar to those of a family: 1) the reproductive structures, which are to be considered as the true distinctive character; 2) the vegetative organs; 3) observations peculiar to the genus and showing the natural affinities."

## The Species

"The Ariadnean thread of the systematists terminated in *Genera*, but I have attempted to extend it so far as *Species*, for which I have made proper differentiae; so that by these differentiae they may endure, for all true recognition begins with the recognition of species. Whatever botanists had built formerly is now collapsed, for it lacked a suitable foundation. But a strong botanical science has grown up in the last eighty years, now so firm that there seems no possibility of its collapse. For there is a solid foundation of species and a definite certainty in genera; for if genera are confused, then everything is confused." Linnaeus, Introduction to *Species Plantarum.*

## The Specific Name

The principle element of *Species Plantarum* was the polynomial specific name, and upon its construction Linnaeus lavished his

skill and placed his greatest emphasis.[30] The specific name was a series of descriptive words (*differentiae*) selected according to rules laid down in *Philosophia Botanica*, by which each species was to be differentiated at first glance from all others in the genus. This method had already been in use in Linnaeus' earlier works and in those of Gronovius and Royen, who were both under the tutelage of Linnaeus.[31] Indeed these polynomials are the definition or boundaries of the individual Linnaean species, which represent units of practical usage within the "compendium" (i. e., "Species Plantarum") of virtually all previously published names, figures, and descriptions. In other words the synthesis of these names, figures and descriptions, together with associated herbarium specimens, constitutes the "species" of Linnaeus. It will be noted that these Linnaean species are in general more comprehensive than species of present usage. The Linnaean species was a somewhat arbitrary unit—according to our standards of today—separated from all other species of the genus by means of the differentiae within the specific name, the entire treatment being comparable to, or even identical with, our modern keys to the species within a genus. These specific names were arranged in numerical order, each preceded by the generic name, with a "trivial" name added in the margin. As an example, with synonyms and bibliographic references omitted, may be cited the first genus treated in *Species Plantarum:*

1. Canna foliis ovatis utrinque acuminatis nervosis. *Indica.*
2. Canna foliis lanceolatis petiolatis nervosis. *angustifolia.*
3. Canna foliis lanceolatis petiolatis enervibus *glauca.*

When genera came to be revised in *Species Plantarum* from their treatment in earlier Linnaean works, a revision of specific names was often necessary in order to provide adequate differentiae. Thus we have (p. 113):

1. Plantago foliis ovatis glabris, nudo scapo tereti, spica flosculis imbricatis. *major.*
   Plantago foliis ovatis glabris. *Hort. Cliff.* . . .

[30] Introd. Sp. Pl.: "To set up the essential characters for the specific name is not an easy task; for it requires an accurate knowledge of many species, a most attentive investigation of the parts, the selection of differentiae, and finally the proper application of the art of terminology, in order that the briefest and most effective name may be arrived at."

[31] Introd. Sp. Pl.: "Differentias specificas antehac Plantis non paucis imposui in Flora Lapponica, Suecica, Zeylanica, in Horto Cliffortiana, Upsaliensi. Iisdem principiis institere Botanici Gronovius, Royenus, etc.".

contrasted with a new species:

2. Plantago foliis ovatis glabris, scapo angulato, spica flosculis distinctis. *asiatica.*
[Here follows a short description].
3. Plantago foliis ovato-lanceolatis pubescentibus, spica cylindrica, scapo tereti. *Hort. Cliff.* 36. *Fl. Suec.* 123. etc. *media.*
4. Plantago foliis lanceolato-ovatis pubescentibus subdenticulatis, spicis cylindricis pubescentibus, scapo angulato. *Gron. virg.* 16. *virginica.*

The characteristics of the specific name and rules for its formation I have extracted from paragraphs in *Philosophia Botanica* (1751), together with some of the longer explanatory notes provided in "Critica Botanica" (1737).

256. A plant is perfectly named when it has a generic and a specific name. The idea of a species lies in the essential character by which alone the species is distinguished from its congeners. The *differentia specifica* contains the characters (*notae*) by which a species is distinguished from its congeners. Therefore the specific name contains the essential characters of the *differentia.*[32]

257. The specific name should distinguish the true plant from all congeners. This is the fundamental rule for specific names; if neglected, all will be confusion. All nomina specifica which do not distinguish a plant from the congeners are false; and all nomina specifica which distinguish the plant from others not in the same genus are false. The *nomen specificum* is therefore the *differentia essentialis.*

258. The specific name makes the plant recognizable at first glance, since it contains the differentia inscribed in the plant itself. The *character naturalis* of a species is the *Descriptio;* but the *character essentialis* is the *Differentia.* I was the first to base *nomina specifica* on essentials; previously no differentiae of value had been set up. My *nomina specifica* are based on *Differentiae* taken from the *Descriptio;* from the *Differentiae* is traced out the *character essentialis* in which nomina specifica are constant. Some of the recent botanists, such as Royen, Gronovius, Guettard, and Dalibard have accepted this method in entirety; Haller, Gmelin, and Burmann have accepted it in part. To be excluded from the specific name are all accidental things not existing in the plant itself or things which are intangible, such as place, time, duration, or use.

282. Every differentia is of necessity derived from the number, figure, place and proportion of variable parts of plants. These four fundamentals are the same as in genera, and they are constant everywhere: in the

[32] It would be quite possible to have a specific name without differentiae. Such, in general, were the pre-Linnaean specific names. Only in the Linnaean method did the specific names become mutually dependent on the adjacent specific names. More extended accounts of a species, such as a *descriptio*, might also have *differentiae;* but such as were selected for use in the specific name became the *differentia specifica.* Since in the specific name only restricted or essential differentiae were permitted, the *nomen specificum* became actually the *differentia essentialis* (cf. 257 and following sections).

[living] plant, in the herbarium, and in icones. (Critica Botanica: On these four fundamentals—number, figure, proportion and place—depend the external structure of the plant by which alone its difference from others is represented to us. It is these characteristics and no others which we represent in icones. It is these which we preserve in the herbarium, for all others may be accidental. No character in any part of the plant which cannot be referred to one of these four, can we assume as perfect and certain).

283. Care must always be taken that the variety is not used in place of the species. This is a difficult problem and must be looked into with the greatest of care. Errors arise and we are frequently blind, the chief causes being as follows: 1) the diversity and variability of nature, never ceasing in its operation; 2) the diversity and peculiarities of regions and climates; 3) remote places of origin; 4) the brevity of human life, which by fate perishes at an early day. (Critica Botanica: Figure, number, proportion, and location give us clear ideas, nor do they ever fail us; but, assuming them to be of fundamental importance, it is necessary to apply them to stable and not variable parts. Figure, number, proportion, and location do vary in plants, though rarely, and not all at the same time, nor in all parts of the plant at the same time. They vary, though less than other characteristics, and not enough to cause structural differences. Thus the task of the botanist in *differentiae* is double: to distinguish varieties from species and to express in exact words the characters which are inherent in distinct species. . . . The botanist who is more accustomed to the herbarium than living plants thinks the smallest difference to be the character of a distinct species, but he who has gone through the fields finds new species more difficult to discover. Likewise, they who cultivate plants in gardens only, where plants often change, commonly believe that they have more species than actually is the case, if they do not take the trouble to examine wild plants. To prevent unnecessary species there is no more apt and certain method than: 1) a careful examination of all parts of the plant, especially the fulcra [i. e., stipules, bracts, etc.]; 2) careful study of the ovary in all its parts; 3) a search for the most apparent differentiae in related species, for Nature does not make a *saltus*, but commonly uses the same method in a single genus; 4) a search for affinities or diversities, if any, in species which have been placed under another and adjacent genus because of diverse habits; 5) cultivation in diverse soils, which often change species already transformed by culture).

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To separate species or genera by a single character, if possible, has always been a goal of systematists, ancient and modern. Such a single character is seen in "*Eriophorum spicis pendulis*" in *Flora Lapponica*, and it constitutes a *nomen specificum essentiale*. Where several characters are necessary, the specific name becomes *synoptic*, as in "Salix *foliis subintegerrimis lanceolato-linearibus longissimis acutis: subtus sericeis, ramis virgatis*" of *Flora Suecica*. For these procedures, the following extracts from *Philosophia Botanica* and *Critica Botanica* are quoted:

288. The true nomen specificum is either *Synoptic* or *Essential*. Nomina specifica distinguish species definitely, easily, and with certainty. A selection should be made from all possible differentiae of the species, from which the most outstanding are chosen, so that, finally, the species will be clearly recognized. (*Critica Botanica:* The *nomen specificum* is worthless unless there is a primary characteristic taken from the differentiae, by which I can rapidly, surely, and easily distinguish the species from all others in the same genus. Therefore all nomina specifica are false and not genuine, which include other characteristics (notae) than those distinctive of the species, since then the treatment runs into a *descriptio*. If I find no characteristic [nota] alone peculiar to the species, it is necessary to look for a few characters common to a few species of the same genus, but not to all the species; and these characters being found, then one peculiar in a higher degree, until I finally come to the ultimate subdivision. Hence all specific names are said to be either *essential* or *synoptic*. The differentia may be partly essential, partly synoptic; for if I begin a specific name by synoptic division, as soon as possible I shall use an essential character by which the name may be readily shortened).

289. The synoptic name employs semi-dichotomous characters for the plants of a genus. Where the *notae essentiales* cannot be found, it is necessary to make the differentia by synopsis; therefore the synopsis is a substitute for the *differentia essentialis*. In large genera we must usually employ the synoptic method.

290. The *nomen specificum essentiale* (288) has a single character of differentiation, peculiar to this species alone. It is presented in one or two words, or as a single idea. When genera and species have been stabilized, limited by the *differentia essentialis*, we have reached the highest point in *re Herbaria*. This name commends itself in brevity, facility, and certainty. A synopsis should not be admitted into the *differentia specifica* when a *nomen essentialis* has been detected; when the *nomina essentialia* have been worked out, we have reached the final goal.

294. Whoever discovers a new species adds not only the differentia of this species, but emends the differentiae in other species of the genus, so that the species may be distinguished in posterity.

Closely bound up with this last statement is the practical usage of synonyms. Under section 318, Linnaeus mentions that the earliest botanists were content with generic names.

"Succeeding botanists applied names arbitrarily, but Caspar Bauhin (1622) combined the names of these previous authors and reduced them to 6000. The 'Curiosi', interested only in new plants, doubled the number of names which previous authors had made. Bauhin's 'Pinax' was continued by Sherard, and in 1728 he left it to Dillenius, who died in 1747 with the work still uncompleted. Haller, in various publications, elaborated the absolute synonymy of the plants of Switzerland. A work of absolute synonyms is of the greatest necessity to botanists, for if the name of one author is detected all [the synonyms] are known."

Among synonyms (319) the best name leads the list, and it should be so chosen by the author, either from among his own names or from someone else's. Synonyms (320) may be arranged

in two ways, either descending (from the oldest to the newest) or ascending (from the new to the ancient). In the *descending*, the author's name heads the list, and the synonyms are arranged chronologically, as with Haller and Dillenius. In the *ascending*, names are arranged by genera [i. e., not mixed], and these proceed from the more recent to the ancient; this form has most often been used by me.[33]

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With this account of the specific name and its differential function together with a very brief review of synonymy, we are in a position to treat the subject from the practical view of modern nomenclature. In 1939[34] I came to the conclusion that the recent change in the name of the northern red oak (*Quercus rubra*) was wholly unnecessary. And the same applies to many other Linnaean names that have been shifted about, chiefly, it seems to me, from a lack of understanding of the Linnaean method. The Linnaean treatment of the American oaks, with the exception of *Q. Phellos*, is reproduced here from the first edition of *Species Plantarum:*

[p. 995] 6. QUERCUS foliis ovatis indivisis spinoso-dentatis glabris. *Roy. lugdb.* 8. *Coccifera.*
Quercus foliis ovatis dentato-spinosis, glandibus sessilibus. *Sauv. monsp.* 96,
Ilex aculeata cocciglandifera. *Bauh. pin.* 425.
Ilex coccifera. *Cam. epit.* 774.
*Habitat in* G. Narbonensi, Hispania. ♄

7. QUERCUS foliis obovatis utrinque acuminatis sinuato-serratis: denticulis rotundatis uniformibus. *Hort. cliff.* 448. *Gron. virg.* 117. *Roy. lugdb.* 80. *Prinus.*
Quercus, castaneæ foliis, procera arbor, virginiana *Pluk. alm.* 309. *t.* 54. *f.* 3. *Raj. hist.* 1916. *Catesb. car.* 1. *p.* 18. *t.* 18.
*Habitat in* America *boreali.* ♄

8. QUERCUS foliis cuneiformibus obsolete trilobis. *Gron. virg.* 117. *nigra.*
Quercus folio non serrato in summitate quasi triangulo. *Catesb. car.* 1. *p.* 20. *t.* 20.

[33] A. DeCandolle. Lois de la Nomenclature Botanique. 1867, p. 8. "I may say, in commencing, that there is a certain inquietude today caused by the great complication of synonymy. The botanists with but little experience will not be greatly affected. They will not adopt new names unless the necessity for them is stated, or at least until they are sure that the names have been approved, after examination by many competent men. After all, synonymy is not without merit. It constitutes the history of the science. Completely given, in order of dates, it is often instructive and interesting . . . Will the increase of synonyms continue in the same manner for a long time? That does not seem to be at all probable."

[34] Rhodora **41**: 521–524.

[p. 996] β. Quercus marilandica folio trifido ad sassafras accedere dente. *Raj. Catesb. car.* 19. t. 19.
*Habitat in* America *septentrionali.* ♄

*rubra.* 9. QUERCUS foliis obtuse-sinuatis sètaceo-mucronatis.
Quercus foliorum sinubus obtusis: angulis lanceolatis seta terminatis integerrimis vix divisis. *Gron. virg.* 117.
Quercus èsculi divisura, foliis amplioribus aculeatis. *Pluk. alm.* 309. *t.* 54. *f.* 4. *Catesb. car.* 1. *p.* 23. *t.* 23.
β Quercus foliorum sinubus obtusis: angulis acutis seta terminatis: intermediis vix tridentatis margine integerrimo. *Hort. cliff.* 448. *Roy. lugdb.* 80.
Quercus carolinensis, virentibus venis muricata. *Catesb. car.* 1. *p.* 21. *t.* 21. *f.* 1.
Quercus virginiana venis rubris muricata. *Pluk. alm.* 309. *t.* 54. *f.* 1.
*Habitat in* Virginia, Carolina. ♄

*alba.* 10. QUERCUS foliis oblique pinnatifidis: sinubus angulisque obtusis.
Quercus foliis superne latioribus opposite sinuatis, sinubus angulisque obtusis. *Gron. virg.* 117.
Quercus alba virginiana. *Catesb. car.* 1. *p.* 21. *t.* 21. *f.* 2.
*Habitat in* Virginia. ♄

With the help of Mr. Savage I examined the specimens of *Quercus* in the Linnaean Herbarium in London in 1937, representing the following trivial and specific names:

7. (Prinus) Quercus foliis obovatis utrinque acuminatis sinuato-serratis: denticulis rotundatis uniformibus. Hort. Cliff. etc.
8. (nigra) Quercus foliis cuneiformibus obsolete trilobis. Gron. Virg.
9. (rubra) Quercus foliis obtuse-sinuatis setaceo-mucronatis.
10. (alba) Quercus foliis oblique pinnatifidis: sinubus angulisque obtusis.

In *Q. Prinus* and *Q. nigra* the specific names were taken over without change from their usage in *Hortus Cliffortianus*, Gronovius' *Flora Virginica*, and Royen's account of the Leyden Garden. In the case of *Q. rubra* the synoptic specific names from these same sources were combined into a simple essential name according to the rules laid down in section 290 of *Philosophia Botanica*, but one of the synoptic names was retained as the var. β., which was differentiated by the somewhat 3-toothed apices of the leaf lobes. The specific name of *Q. alba* was a modification of the Gronovian name to form a better differential with the European *Q. Robur*. It should be noted that the older

specific name now has become a synonym. It is of great importance to recognize that the individual Linnaean synonyms were *nomina*, often used successively in various publications for objects of entirely different origin (often from our present point of view applied to objects which we regard as representing distinct species). To Linnaeus they all represented variability within the same species. Such for example is *Quercus esculi divisura, foliis amplioribus aculeatis* derived by Linnaeus from the illustrations of Plukenet and of Catesby; in this case Catesby had used Plukenet's name for quite a different kind of oak. It is quite evident that the Linnaean species was an aggregate of wild plants, as treated in *Flora Suecica;* cultivated plants, as in *Hortus Upsaliensis* and *Hortus Cliffortianus;* herbarium specimens in the Linnaean Herbarium, and those seen by Linnaeus in other herbaria; and lastly, figures and descriptions of which herbarium specimens were not seen. This is substantially the opinion to which C. B. Clarke[35] came, and likewise Spencer Savage, our foremost authority on Linnaean procedure[36]:

"A considerable number of the plants described in the first edition of the 'Species Plantarum' cannot be said to have type-specimens in the ordinarily accepted sense. Linnaeus renamed and placed systematically a large number of plants that had been known to botanists for centuries,—a different thing from naming and describing a species for the first time. The Linnaean 'type' of any such well-known species will surely be found to consist of *all* the surviving herbarium specimens determined by Linnaeus at the time he wrote the diagnosis. A 'species' in Linnaeus's sense was not founded on an individual specimen, but was rather an intellectual concept of a natural group, even though that group was part of an artificial system. The specimens he determined he considered to be typical of such a group".

This subject will be discussed further under the heading of "Herbarium", but I wish to point out that the Linnaean species from one point of view was the synthesis of all bibliographic citations under the species, together with Linnaean herbarium specimens, whether or not they were associated with citations. From a second point of view, and a very important one, the species represented that portion of a genus which was included

[35] Journ. Linn. Soc. **30**: 299. 1895. "Linnaeus conceived a species as an entity and did not suppose that it could be restricted to one 'type'. A 'species', in his Sp. Pl., is made up of 4 (or fewer) parts." See footnote 11.

[36] Catalogue of the manuscripts in the library of the Linnaean Society of London. Part II. Caroli Linnaei determinationes in hortum siccum Joachimi Burseri. Ed. Spencer Savage, 1937, p. 5.

under and defined by the specific name, of which the differential character has been discussed. It may be argued that this was not the idea of species of the present day, which in general are drawn on narrower lines. The corollary is that most species of *Species Plantarum* comprise two or more species as recognized in the modern consensus. It must be remembered that *Species Plantarum* was a tentative and artificial system. Natural species, as Linnaeus recognized, should be based on experimental cultivation, i. e., they were plants which came true to seed. But neither in Linnaeus' day or in the present day could a comprehensive classification be made on the basis of experimental data. The synthetic nature of species as treated in *Species Plantarum* was emphasized by the fact that the work was primarily without descriptions, and that reference to a description was made by the use of an asterisk.[37] "Only in obscure cases has it been necessary to add descriptions, and these are without ambiguity, so that I may keep the handbook acceptable to the beginner."[38]

Especially as knowledge of the American and Asiatic floras increased, these Linnaean species were subjected to analytic treatments by later writers, and broken up into smaller units. As to the limits of species there is no unity even among botanists of the present day.[39] By Linnaeus himself specific names were corrected and restricted in succeeding editions of *Species Plantarum*.[40]

[37] Cf. Scirpus culmo nudo setaceo, spicis lateralibus subsolitariis sessilibus. it. scan.* (Sp. pl. p. 49), and Scirpus culmo triquetro nudo, umbella simplici, spicis ovatis. Fl. zeyl. 38*. (Sp. pl. p. 50).

[38] Introd. Sp. Pl.: Descriptiones tantum in obscuris adhibere necessum fuit, easque sine ambagibus, ut obtinerem compendium tironibus gratum. Cf. Rhodora **41**: 139–140. 1939. It is obvious that Linnaeus placed the asterisk after the word "DESCRIPTIONES", in ed. 2, to call attention to the fact that the sign meant a cited description.

[39] Bentham, perhaps the greatest of systematic botanists (Trans. Linn. Soc. **27**: 507. 1871): "whether we follow Closs in breaking it (*Cassia Candolleana*) up into three species, or with Vogel regard it as a single representative species, or, as suggested by some others, reduce it to a variety only of the widely spread *C. bicapsularis*, its geographical and natural relations remain the same. I have, in the following enumeration, after much hesitation classed it as a variety; but all that is thereby meant is that, upon weighing all the evidence afforded by the materials at my disposal, it has appeared to me that its relationship to the other forms of *C. bicapsularis* is rather of that degree which botanists whose views I adopt call varieties than of the remoter degree which they term species."

[40] Thus in the second edition of *Species Plantarum*, *Scirpus geniculatus* was restricted to the plant with articulate culms and elongated spikes, whereas in the first edition it had included also the round-headed plant, *Scirpus* (*Eleocharis*) *caribaeus*

Several fallacies have crept into the interpretation of Linnaean procedure, one being that a new specific name ("diagnosis") is based on herbarium specimens at hand.[41] Such a new specific name was (as previously mentioned) either 1) a new name constructed according to the rules in *Philosophia Botanica*, as in the example (*Quercus foliorum . . . divisis*) in Gronovius' *Flora Virginica*, 117 (1739):

*Quercus foliorum sinubus obtusis, angulis lanceolatis seta terminatis integerrimis vix divisis.*
Quercus Esculi divisura, foliis amplioribus aculeatis. *Plukn. Alm.* p. 309, t. 54, f. 4. **Red-Oak**. Catesb. Hist. Carol. vol. I. t. 32.
Quercus rubra seu Hispanica hic dicta, foliis amplis varie profundeque incisis. *Clayt.;*

or 2) a shortening of the specific name from synoptic to essential form (cf. *Quercus foliis obtuse-sinuatis setaceo-mucronatis*. Sp. Pl. p. 996); or 3) change in an adjacent name due to interpolation of a new species into the genus. In the citation just made from Gronovius' Flora, the old specific name of Plukenet was taken up

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(or *S. capitatus*, according to a specimen placed later by Linnaeus in his herbarium, but not according to the immature specimen which Linnaeus had formerly seen in the Gronovian herbarium and which formed the basis of the treatment in the first edition).

Following Gronovius, *Cerasi similis arbuscula mariana, padi folio, flore albo parvo racemoso* of Plukenet and Catesby was included by Linnaeus as a synonym under *Prunus floribus racemosis, foliis deciduis basi antice glandulosis* Sp. Pl. 473. 1753. This Linnaean species quite evidently included the species now recognized as *Prunus virginiana* L., *P. serotina* Ehrh. and *Itea virginica* L. Between the issue of the first and second editions of *Species Plantarum*, Linnaeus realized that the Plukenet figure represented *Itea virginica*. Torrey & Gray, Fl. N. Am. **1**: 410. 1840, discussed the situation as follows: "The Prunus Virginiana of Linnaeus was founded on the present species (the Choke-Cherry), as appears from his description [i. e., specific name] and herbarium: but the synonym adduced from Gronovius relates to the succeeding species [*P. serotina*] that of Plukenet (omitted in ed. 2) to Itea Virginica! and that of Catesby (which was afterwards erased by Linnaeus in his own copy of the Species Plantarum) to Cerasus Caroliniana."

In passing, it might be mentioned that the difficulties in the interpretation of dioecious vines such as *Dioscorea* and *Cissampelos* from pictures and meager herbarium specimens was exceedingly difficult.

Plukenet's figure representing *Bryoniae similis floridana* listed by Linnaeus under *Dioscorea villosa*, Sp. Pl. p. 1033, represents the staminate flower of *Cissampelos Pareira*.

[41] In the treatment of *Hedysarum violaceum* (Sp. Pl. 749) there is a new specific name, and one might say on the basis of this argument that Linnaeus had derived this new name ("diagnosis") from a specimen at hand, since a real *description* is appended to the treatment. But in discussing *Lespedeza violacea*, Britton (Trans. N. Y. Acad. Sci. **12**: 62. 1893) says: . . . "as illustrated by his own [Linnaeus'] herbarium the species is complex, but the specimens are not the types of the species." The Gronovian reference [based supposedly on a specimen not to be found at the British Museum] is taken as the type. Schindler (Bot. Jahrb. **49**: 587. 1913) intimates that Linnaeus had a Gronovian specimen under his eyes.

also by Catesby, but merely in a bibliographic sense, and applied by Catesby to a wholly different plant—as we see it today. This old Plukenet name now became a synonym. To this treatment was added the phrase from Clayton, which was in no sense a name or synonym, but merely a translation into Latin by Gronovius of the original English descriptive notes which accompanied the numbered (and unnumbered) specimens. It is quite evident from the much longer descriptive account of *Ruellia* (Fl. Virg. p. 73) that such descriptive notes were not specific names according to the Linnaean method under which Gronovius worked:

Ruellia foliis petiolatis, fructu sessili conferto. *Linn. Hort. Cliff. p.* 318. *n.* 1.

Ruellia strepens, capitulis comosis. *Dill. Hort. Elth. p.* 300. *T.* 240. *f.* 321.

Ruelliae Species flore amplo coerulea inferne tubulato, superiore in quinque segmenta expanso, cito marcescente, in summo caule & ad nodos florens, foliis oblongis hirsutis serratis ex adverso binis, vasculo longo rotundo, bicapsulari, semine compresso. *Clayt. n.* 85 & 98[42].

(*To be continued*)

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Senecio Smallii Britton, forma **tristis,** f. nov., ligulis nullis. —Virginia: a single clump at the dry border of "Ram-hole Swamp," Seward Forest, near Triplett, Brunswick Co., May 12, 1945, *Fernald,* no. 14,859 (type in Herb. Gray.).

As I have elsewhere predicted, sooner or later a discoid form may be found in any member of § *Aurei,* so that the character "discoid", as opposed to "radiate", is not a sound one for use in keys.—M. L. Fernald.

[42] A description of *Ruellia strepens* was first given by Linnaeus in Mantissa 2: 422. 1771.

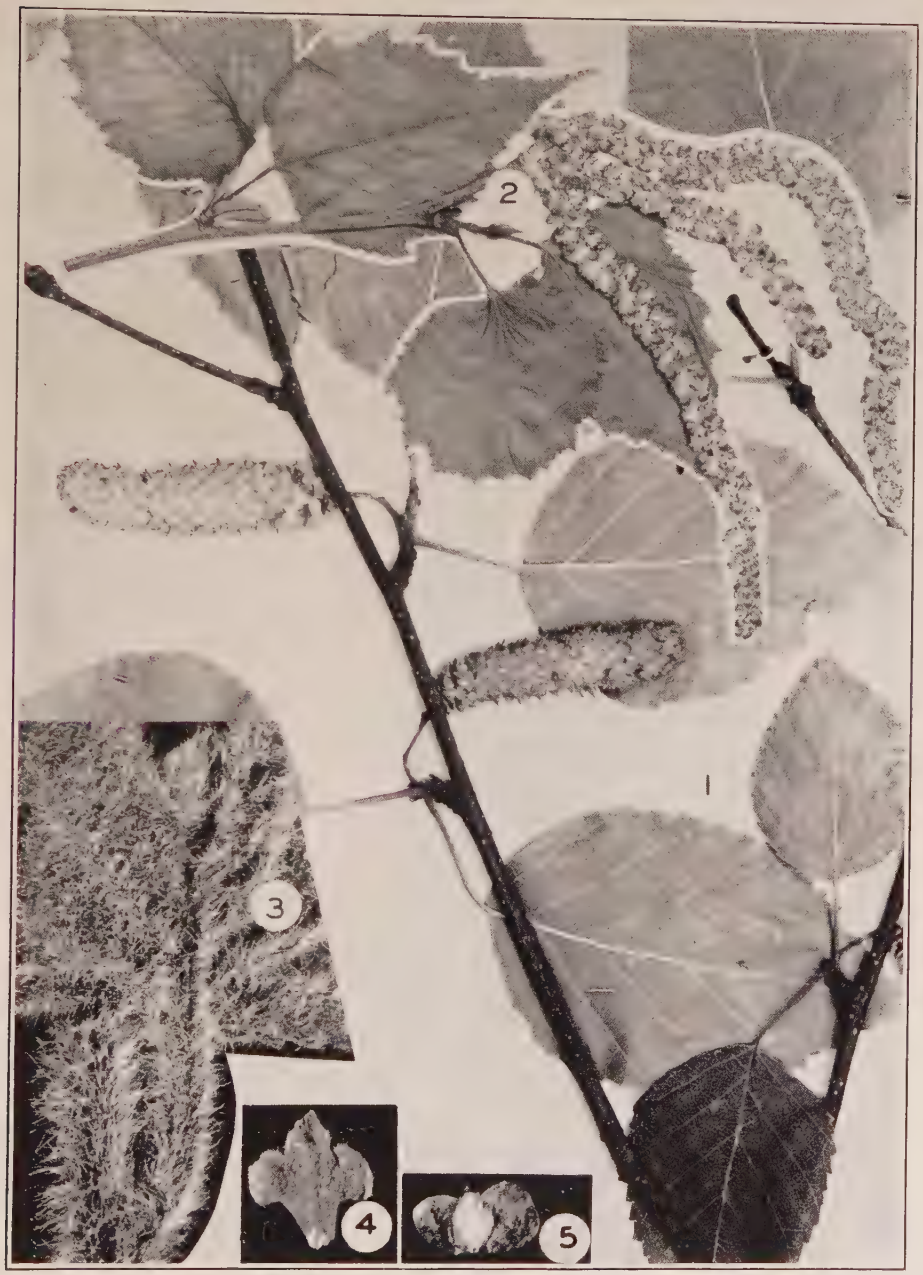


*Photo. B. G. Schubert*

BETULA PAPYRIFERA: FIG. 1, fruiting branch, × 1; FIG. 2, staminate aments, × 1; FIG. 3, tip of young shoot, × 5; FIG. 4, fruiting bract, × 4; FIG. 5, samara, × 4.

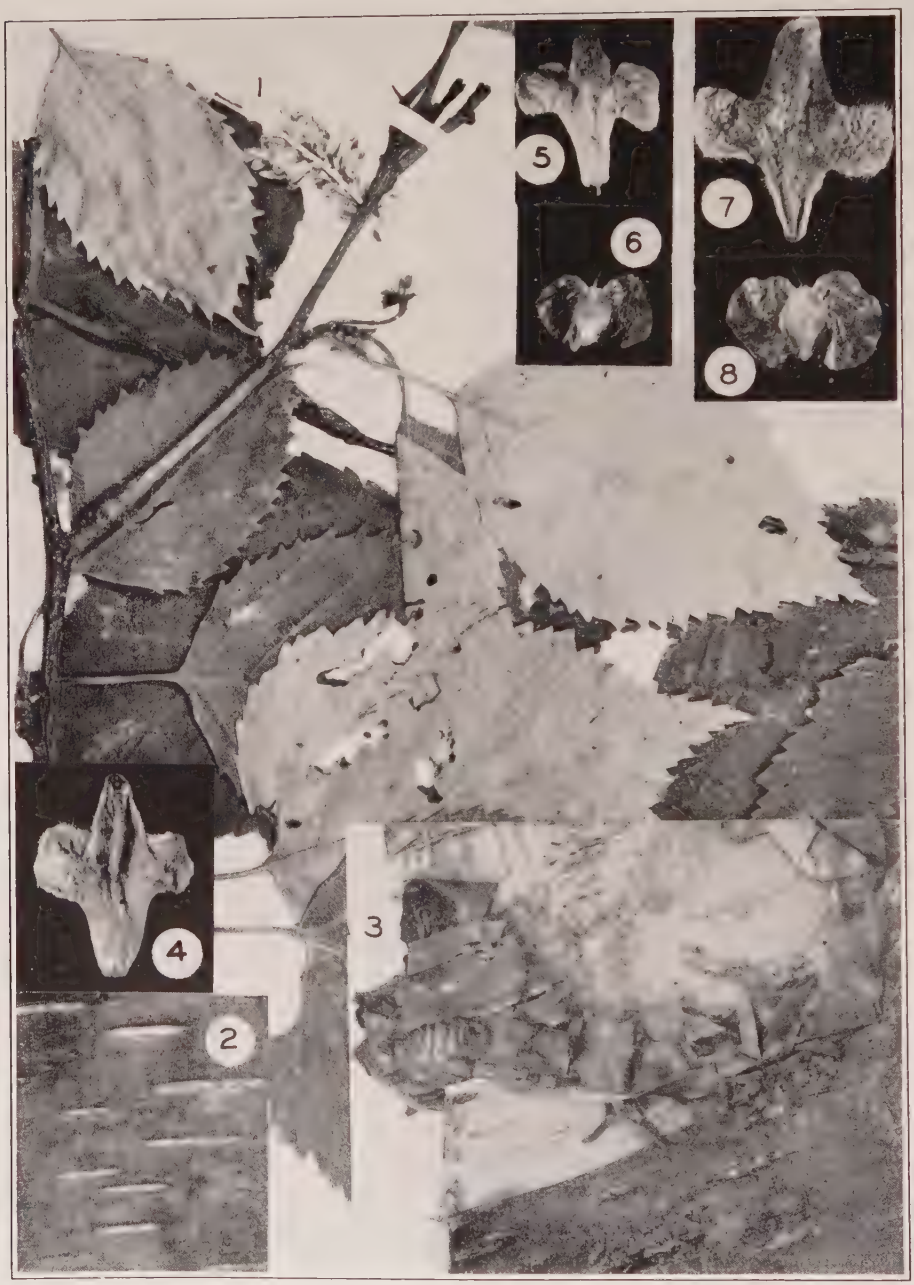


*Photo. B. G. Schubert*

BETULA PAPYRIFERA, var. COMMUTATA: FIG. 1, portion of *Lyall's* specimen, × 1; FIG. 2, characteristic close bark, × 1; FIG. 3, exfoliating bark from base of old trunk, × 1; FIGS. 4, 5 and 7, fruiting bracts, × 4; FIGS. 6 and 8, samaras, × 4.


*Photo. B. G. Schubert*

BETULA OCCIDENTALIS, var. FECUNDA: FIG. 1, portion of TYPE, × 1; FIG. 2, flowering branchlet, × 1; FIG. 3, staminate aments, × 1.


*Photo. B. G. Schubert*

BETULA PAPYRIFERA, var. PENSILIS: FIG. 1, portion of TYPE, × 1; FIG. 2, fruiting bract, × 4; FIG. 3, samara, × 4; FIG. 4, branch with younger aments, × 1.


*Photo. B. G. Schubert*

BETULA PAPYRIFERA, var. MACROSTACHYA: FIG. 1, portion of TYPE, × 1; FIG. 2, fruiting bract, × 4; FIG. 3, samara, × 4.

Var. MACROSTACHYA, forma LONGIPES: FIG. 4, portion of TYPE, × 1.


*Photo. B. G. Schubert*

BETULA PAPYRIFERA, var. ELOBATA: FIG. 1, portion of TYPE, × 1; FIG. 2, immature samara embraced by bract, × 4; FIG. 3, immature bracts, × 4.


*Photo. B. G. Schubert*

BETULA PAPYRIFERA, var. CORDIFOLIA: FIG. 1, portion of fruiting branch, × 1; FIG. 2, tip of vigorous sprout, × 5; FIG. 3, fruiting bract, × 4; FIG. 4. samara, × 4.


*Photo. B. G. Schubert*

BETULA PAPYRIFERA, var. HUMILIS: FIG. 1, portion of branch and Regel's label, from TYPE, × 1; FIG. 2, lower surface of leaf, × 10; FIG. 3, fruiting bract, × 4; FIG. 4, samara, × 4; FIG. 5, fruiting tip, × 1.


*Photo. B. G. Schubert*

BETULA PAPYRIFERA, var. HUMILIS: FIG. 1, specimen, × 1, cited by Sargent as his *B. alaskana;* FIGS. 2 and 4, fruiting bracts, × 4; FIGS. 3 and 5, samaras, × 4.


*Photo. B. G. Schubert*

BETULA BOREALIS: FIG. 1, mature branchlets, × 1; FIG. 2, immature fruiting branch, × 1; FIG. 3, tip of young branch, × 5; FIG. 4, fruiting bract, × 4; FIG. 5, samara, × 4.


*Photo. B. G. Schubert*

BETULA UBER: FIG. 1, fruiting branchlets from ISOTYPE, × 1; FIG. 2, upper surface of half a leaf, × 2, showing venation and toothing; FIG. 3, portion of lower surface of leaf, × 2; FIG. 4, fruiting bract, × 4; FIG. 5, samara, × 4.

B. LENTA: FIG. 6, lower surface of half a leaf, × 1, to show venation and toothing; FIG. 7, fruiting bract, × 4.


*Photo. B. G. Schubert*

BETULA TERRAE-NOVAE: FIG. 1, portion of TYPE, × 1; FIG. 2, tip of fruiting branchlet, × 5; FIG. 3, two fruiting bracts, × 10; FIG. 4, nutlet, × 10.
B. NANA: FIG. 5, tip of branchlet, × 5; FIG. 6, fruiting bract, × 4; FIG. 7, samara, × 10.

# CONTRIBUTIONS FROM THE GRAY HERBARIUM OF HARVARD UNIVERSITY—No. CLIX

## SOME NORTH AMERICAN CORYLACEAE (BETULACEAE)

M. L. Fernald

(Plates 963–989)[1]

### I. Notes on Betula in eastern North America

(Plates 963–975)

It has long been evident that the ultraconservative treatment of *Betula*, published by me in 1902, as *Relationships of some American and Old World Birches*[2], can not be accepted, in view of the many characters of aments, their bracts and samaras then not understood. That sophomoric study, based on complete lack of understanding, well illustrates how an over-conservative treatment may be as far afield as are those which split beyond the normal divergencies in Nature. In a recent attempt to set in order the White Birches and the Dwarf Birches as they occur in the Gray's Manual range the names applied to our species and varieties have necessarily changed in several cases. The entire treatment can hardly be given here, but, in order to clarify the situation, the key to our members of Series *Albae* is here given.

*a.* Bark opaque, chalky- or ashy-white, close, the layers not readily exfoliating; staminate ament usually 1 and, before expanding, pointing stiffly forward; leaves glabrous or merely glutinous on both sides, abruptly ending in prolonged tail-like tips (caudate); fruiting aments 1–2.5 cm. long; their mature bracts nearly horizontally divergent, crowded, 3–4.5 mm. long, uniformly ashy-puberulent on back . . . . . 1. *B. populifolia.*

*a.* Bark lustrous, creamy- or pinkish-white to warm-brown, in maturity often exfoliating or separating into layers; staminate aments 1–few; leaves not prominently caudate-tipped; fruiting aments (except in the dwarf shrubby no. 4) mostly larger; their bracts (except in the introduced no. 2) ascending, glabrous or pilose on back, the lobes ciliate . . . . *b.*

*b.* Samaras 3.5–6.5 mm. broad, the wings broader than the achene; trees or coarse shrubs.

[1] The cost of preparing and engraving the plates met in part through a grant from the American Philosophical Society.

[2] Contrib. Gray Herb. n. s. xxiii., Am. Journ. Sci., ser. 4, xiv. 167–194, plates v and vi (1902).

*c.* Leaves glabrous on both sides; young shoots glabrous or merely with resinous warts....*d.*

*d.* Trees with whitish bark; leaves deltoid-ovate, acuminate from broad base, those of fertile branches 3–10 cm. long; staminate aments 4–10 cm. long; lateral lobes of pistillate bracts divergent, larger than terminal lobe; species of low or intermediate altitudes.

Leaves of fertile branches 3–7 cm. long, their cuneate to truncate bases entire; fruiting aments 2–4 cm. long, their bracts divergent; introduced species....2. *B. pendula.*

Leaves of fertile branches 5–10 cm. long, their rounded bases toothed except near petiole; fruiting aments 2.5–5 cm. long, their bracts ascending; indigenous.....3. *B. caerulea-grandis.*

*d.* Shrub with dark close bark; leaves ovate, merely acute to blunt, those of fruiting branches 1.5–4.5 cm. long; staminate aments 1.5–3.5 cm. long; lateral lobes of pistillate bracts ascending, scarcely broader than terminal lobe; subarctic-alpine species.....4. *B. minor.*

*c.* Leaves pubescent beneath, at least when young, or on veins or in their axils; young vegetative shoots pubescent or puberulent.

Buds lustrous with resin; leaves merely acute, those of fertile branches 3–5 cm. long; mature fertile aments 1.5–3 cm. long; introduced species.....5. *B. alba.*

Buds scarcely resinous; leaves mostly acuminate, those of fertile branches 2.5–10.5 cm. long; mature fertile aments 1.5–6.5 cm. long; indigenous.....6. *B. papyrifera.*

*b.* Samaras 2–3.5 mm. broad, the wings scarcely to barely as broad as the achene; new sprouts pubescent; leaves elliptic, rhombic-oval or ovate; shrub with close dark bark.....7. *B. borealis.*

1. B. POPULIFOLIA Marsh. Arb. Am. 19 (1785). *B. alba* L., var. *populifolia* (Marsh.) Spach, Ann. Sci. Nat. sér. 2, xv. 187 (1841).—Sterile dry to wet acid soils, Prince Edward Island to Laurentide region of Quebec, west to southern Ontario, south to Delaware, Pennsylvania, upland to Virginia, northern Ohio and northern Indiana.

B. POPULIFOLIA Marsh., forma **incisifolia,** f. nov., foliis lacerato-incisis, laciniis attenuatis plus minusve incisis.—MASSACHUSETTS: old field at border of woods, Auburndale, July 23, 1941, *D. S. Correll* (TYPE in Herb. N. E. Bot. Club). PENNSYLVANIA: along trail just north of highway, below the Pagoda, Mt. Penn, Berks Co., Aug. 14, 1943, a single young individual, *Wherry.* Illustrated as var. *laciniata* Loud. by Correll in RHODORA, xliv. plate 708 opp. p. 236 (1942).

Unfortunately the name *Betula populifolia,* var. *laciniata* (Lodd.) Loud., currently used for this "cut-leaved" form, is not a safe one to take up. The identity is too doubtful since Loudon based it on a *nomen nudum* which had been published by Conrad Loddiges and Sons, Nurserymen, in their 16th Catalogue

of Plants, 44 (1836). Loddiges and Sons merely had the name *Betula laciniata* in a list of hardy trees and shrubs cultivated by them. There was no description; consequently when Loudon, Arb. and Frut. Brit. iii. 1707 (1838), published *B. populifolia*, var. *laciniata*, "*B.* laciniata *Lodd.* Cat. ed. 1836, has large, smooth, shining, deeply cut leaves, and appears to us to belong to *B.* (*a.*) populifolia, rather than to *B.* alba", he based his combination on a *nomen nudum*. If he had omitted the citation of Loddiges' identical *nomen* which was further invalidated by the well described *B. laciniata* Ehrh. (1788), the case would be different. At least, if it be maintained that Loudon gave a sufficient diagnosis and thus validated the name, it is not at all certain what he had. It is safer to establish our indigenous form on surer ground.

2. B. PENDULA Roth, Tent. Fl. Germ. i. 405 (1788). *B. alba* L. Sp. Pl. 982 (1753), in part; Koch, Syn. 662 (1837). *B. alba*, β. *pendula* Ait. Hort. Kew. iii. 336 (1789). *B. verrucosa* Ehrh. Beitr. vi. 98 (1791–1793).—Introduced from Europe; spread to roadsides, thickets, open woods, etc., Nova Scotia to Ontario, south to Pennsylvania, Michigan, Wisconsin and Iowa.

Forma DALECARLICA (L. f.) Schneid. Handb. Laubholzk. i. 112 (1904). *B. alba*, β. *dalecarlica* L. f. Suppl. 416 (1781).—Similarly spreading from cultivation.

Those who treat this half of the mixed *Betula alba* L. as typical *B. alba* (for instance Beck von Mannagetta and Wilmott) go back only to Koch (1837) for their cue. Evidently they have overlooked the fact that Roth in 1788 had removed *B. pendula*, thus leaving the other species (*B. pubescens* Ehrh., 1791) to stand as true *B. alba*. See comments under our no. 5.

3. B. CAERULEA-GRANDIS Blanchard, Betula, i. no. 1 (May 7, 1904); Fernald in RHODORA, xxiv. 171 (1922). *B. caerulea* Blanchard, var. *grandis* Blanchard in Vermont Phoenix for May 13, 1904 and Betula, i. no. 2 (May 13, 1904). *B. caerulea*, var. *Blanchardi* Sargent, Man. Trees. N. A. 202, fig. 168A (1905).—Dry woods, Gaspé Peninsula to Montmorency Co., Quebec, south to Nova Scotia, northern New England and eastern New York.

× B. CAERULEA Blanchard, Betula, i. no. 1 (May 7, 1904); Sargent, Man. 201, fig. 168 (1903); Fernald in RHODORA, l. c. 172 (1922)—A hybrid of no. 3 with no. 1, occasional where they are together.

4. B. **minor** (Tuckerm.), stat. nov. *B. papyracea*, var. *minor* Tuckerman in Am. Journ. Sci. xlv. 31 (1843). *B. dahurica*, β. *americana* Regel in DC. Prodr. xvi[2]. 175 (1868). *B. alba*, subsp. *papyrifera*, β. *humilis* Regel, l. c. 166 (1868), in small part only (i. e. *B. papyracea*, var. *minor* Tuckerm., the TYPE of which is also the type of Regel's *B. dahurica*, var. *americana!*) *B. papyrifera*, var. *minor* (Tuckerm.) Wats. & Coult. in Gray, Man. ed. 6, 472 (1889), at least in part. *B. odorata*, var. *tortuosa* sensu[1] Fernald in RHODORA, iii. 173 (1901), not (Ledeb.) Lange. *B. alba*, var. *minor* (Tuckerm.) Fernald in Am. Journ. Sci. ser. 4. xiv. 179 (1902).—Acidic rocky barrens, peats and alpine summits, Labrador Peninsula, south to Newfoundland, Shickshock Mts., Gaspé Peninsula, and Laurentide Mts., Quebec, highest mountains of northern New England and northeastern New York, and shores of James Bay, Ontario. The following are characteristic. LABRADOR: head of pond, 30 miles west of Nain, Anatolak Bay, *Potter & Brierly*, no. 2614; Anatolak, *C. S. Sewall*, no. 449; Hopedale, Aug., 1935, *Agnes Ayre;* granite hills, Salmon Bight, 53° 27′ N., 55° 47′ W., *A. E. Porsild*, no. 37, as *B. papyrifera*, var. *cordifolia;* Square Island, lat. 52° 49′, Aug. 16, 1882, *J. A. Allen;* large shrubs on upper crests and on gneiss plain, Blanc Sablon, *Fernald & Wiegand*, nos. 3248 and 3249. NEWFOUNDLAND: shrub 0.5–0.8 m. high, turfy and rocky slopes of Cape Dégrat, Quirpon Island, *Fernald & Long*, no. 28,071, erroneously distributed as *B. microphylla* Bunge; thickets, brooksides and ravines, western side of Quirpon I., *Wiegand, Gilbert & Hotchkiss*, no. 28,076 (as *B. microphylla*); quartzite one half mile south of Deer Pond, Highlands of St. John, *Wiegand, Gilbert & Hotchkiss*, no. 28,078 (as *B. microphylla*); erect, 1 m. or less high, peaty or turfy upper quartzite slopes, alt. 600–650 m., Killdevil, Bonne Bay, *Fernald, Long & Fogg*, no. 1635 (as *B. microphylla*); diorite tableland, alt. about 550 m., northern region of the Blomidon ("Blow-me-down") Mts., Bay of Islands, *Fernald & Wiegand*, no. 4263; diorite tableland, near Franchman's Cove, Bay of Islands, *Griscom*, no. 10,242; about 4 feet high, Riverview Camp, Grand Codroy R., *Pease & Edgerton*, no. 27,113; damp thickets on hill southwest of Tilt Cove, Notre Dame Bay, *Fernald & Wiegand*, no. 5307. QUEBEC: rocky hillsides, Vieux-Fort, Pontchartrain, Saguenay Co., *St. John*, no. 90,831 (as *B. glandulosa*); tundra, Ile Herbée, Archipel de Vieux-Fort, *St. John*, no. 90,832 (as *B. glandulosa*); sur les gneiss près des chutes, Natashquan, Côte-Nord, *Victorin & Rolland*, no. 28,101 (as *B. microphylla*); Seven Islands, Saguenay Co., *C. B. Robinson*, nos. 864 and 867; plateau dénudé, Botanists' Dome, Montagne de la Table, *Rousseau & Fortier*, no. 31,429; abondant près du sommet, Mt. Lyall, Gaspé Co., *Victorin, Rolland &*

[1] For these more erroneous identifications one is tempted to write "*nonsensu.*"

*Jacques*, no. 33,516 (as *B. microphylla*); parties sèches près des sommets, Mont Sterling, Gaspé Co., *Victorin, Germain & Jacques*, no. 33,481 (as *B. microphylla*); rocky slopes and barrens, alt. 650–1100 m., Mt. Albert, Gaspé Co., *Collins & Fernald*, no. 67; on hornblende schist, alt. 900–1060 m., north slope, Mt. Albert, *Fernald & Collins*, nos. 214 and 529 (as *B. microphylla*); sur les schistes hornblendiques et les paragneiss, Mt. Albert, *Victorin, Brunel, Rolland & Rousseau*, no. 17,598 (as *B. pumila* ?); bare hornblende schist near summit, about 1100 m. alt., Mt. Fortin, Matane Co., *Fernald & Pease*, nos. 25,023 and 25,024 (as *B. microphylla*); Port à Pueis, below Cap à l'Aigle, *J. Macoun*, no. 68,776. MAINE: summit of Mt. Katahdin, Aug., 1847, *Aaron Young*, Bot. Surv. Me., Aug. 25, 1847, *George Thurber*, Aug. 12, 1873, *Scribner*, Aug. 1874, *Scribner* (as *B. glandulosa*), Sept. 1898, *E. D. Merrill* (as *B. glandulosa*); small shrubs, summit of 1st North Peak, Mt. Katahdin, July 14, 1900, *Fernald*. NEW HAMPSHIRE: "In alpinis Mont. Alborum", *Tuckerman* (ISOTYPE); White Mts., 1842, *A. Gray*, this and the preceding the types of *B. dahurica*, var. *americana* Regel; Alpine Garden, Mt. Washington, July 10, 1893, *E. & C. E. Faxon*, June 26, 1898, *E. F. Williams* (as *B. glandulosa*), Aug. 5, 1901, *Robinson*, August 13, 1902, *Pease*, no. 445, July 31, 1926, *Pease*, no. 19,828; Oakes Gulf, Mt. Washington, July 4, 1878, *Faxon* (as *B. glandulosa*), July 8, 1895, *Kennedy, Williams;* Oakes Gulf, *Eggleston*, no. 2376 (as *B. odorata*, var. *tortuosa*); 5-mile post on Carriage Road, Mt. Washington, July 27, 1886, *Faxon* (as *B. glandulosa*), *Greenman*, no. 1088 (as *B. glandulosa*), *Pease*, no. 10,532; "Cape Horn", Mt. Washington, June 24, 1898, *Williams, Robinson*, no. 955; Lake of the Clouds, Mt. Washington, July 4, 1878, *Faxon* (as *B. glandulosa*), *Pease*, no. 446; near Duck Fall, Low & Burbank Grant, *Pease*, no. 14,160; Nowell's Ridge, Low & Burbank Grant, *Pease*, no. 12,316; Ice Gulch, Randolph, *Pease*, nos. 10,750 ("trees 2 ft. high"), 16,707; upper rocky slopes of Mt. Lafayette, *St. John*, no. 439. NEW YORK: summit of Mt. McIntyre, alt. 4800–5000 ft., *House*, no. 9488. ONTARIO: Hasey Island, Moose River, James Bay, *D. Potter*, no. 804. PLATE 963, FIGS. 1–7.

*Betula minor* closely simulates the Arctic Eurasian and Greenland shrub, there passing as *B. alba*, var. *tortuosa* (Ledeb.) Schneider or *B. odorata* Bechst., var. *tortuosa* (Ledeb.) Lange or *B. tortuosa* Ledeb. (PLATE 963, FIG. 11). That shrub, however, apparently an arctic extreme of *B. alba*, has the samaras elliptic to obovate (as long as or longer than broad) with wings about equaling the narrow achene. *B. minor*, on the other hand, has the broadly subreniform samaras definitely broader than long,

the wings as broad as or broader than the broadly elliptic achene. A great number of specimens (through my original sin) have been misidentified as the Siberian *B. microphylla* Bunge, but that poorly understood species seems to be unlike anything American (see discussion under *B. borealis*). As for its relationship to *B. papyrifera*, *B. minor* has, somewhat naturally, been inferred to be merely a dwarfed alpine or subarctic extreme of the tree of lower altitudes and more favorable climatic conditions. Examination of the two, however, brings out several important characters. In *B. papyrifera* (PLATES 964, 965 and 967–972) the vigorous young shoots are pubescent; in *B. minor* glabrous but often so gummy as to be mistaken for those of *B. glandulosa*. In *B. papyrifera* the expanding leaves are pubescent beneath, the mature ones with traces of pubescence beneath, at least in the axils of the veins. In *B. papyrifera* the bracts of the pistillate aments (except in vars. *macrostachya* and *cordifolia*) have broad and widely divergent lateral lobes; in *B. minor* the lateral and terminal lobes are of about the same breadth and porrect. Although the lateral lobes of *B. papyrifera*, vars. *macrostachya* (PLATE 968) and *cordifolia* (PLATE 970) are porrect, the bracts are much longer than in *B. minor* and the other characters sufficiently different: both with pubescent new shoots and young foliage, var. *macrostachya* with mature fruiting aments 1.3–2 cm. thick, the samaras 5–6 mm. broad; var. *cordifolia* similar but with definitely cordate leaves; *B. minor* glabrous from the first, often gummy, with very short staminate and fruiting aments, the latter at most 9 mm. thick, and samaras averaging 4.6 mm. wide.

5. B. ALBA L. Sp. Pl. 982 (1753), in part; emend. Roth, Tent. Fl. Germ. i. 404 (1788); Schneid. Handb. Laubholzk. i. 116 (1904); Rendle & Britten in Journ. Bot. xlv. 441 (1907). *B. alba*, α. *vulgaris* Ait. Hort. Kew. iii. 336 (1789). *B. pubescens* Ehrh. Beitr. v. 160 (1790), *nomen only*, vi. 98 (1793—on title page as 1791). *B. tomentosa* Reitter & Abel, Beschr. und Abbild. Deutschl. selt. wild. Holz.-Art. 17, t. 15 (1803).—Introduced from Europe; naturalized on roadsides, in thickets and at borders of woods, Newfoundland to Pennsylvania, west to Michigan.

Although this characteristic European species is passing in this country as *B. pubescens* Ehrh. (1793) it is clear, I think, that

we should retain for it the name *B. alba* L. (1753), as emended by Roth (1788) and as taken up by Aiton (his var. *vulgaris*, as opposed to his var.β. *pendula*). Roth properly split the bipartite *B. alba* of Linnaeus in 1788 into what he considered true *B. alba* and the newly segregated *B. pendula*. Except to those who, following the very simple but also very doubtful Germanic practice of rejecting all Linnean names of European species if they included what are now considered two or more species, the case seems quite clear. *B. alba* in the sense of Roth, who first made the split, and of Aiton, who, the next year, split the species into its two primary elements (as varieties) was thus retained by those very keen students of nomenclature, Schneider in Vienna and Rendle & Britten in London.

If we should apply to North American species of Linnaeus the Germanic idea of rejecting all of his names, which were used for two or more specific elements but which Linnaeus supposed to be conspecific and to both of which the original Linnaean name has been frequently applied, the havoc would be amazing and futile. An embarrassingly large number of the American species of Linnaeus, to say nothing of Old World species from the Orient, were hopeless confusions. Nevertheless, we try to typify them by singling out the element most definitely seeming to be what he primarily intended; or we accept the first clear breaking of the mixture into its primary elements. In case of *Betula alba* the bipartite species was clearly separated into its two primary elements by Roth in 1788. Unless someone earlier segregated them under different names, Roth's typification of *B. alba* should stand.

The name *Betula tomentosa* and that of one of its authors, Reitter (or Reiter) have made endless trouble for those who merely compile from others rather than check the original sources. Thus, from the statement in Dippel, Handb. Laubholzk. ii. 174 (1892), a work in which the illustrations (and apparently the bibliography), right or wrong, were copied from others, we find under *B. alba*, subsp. *pubescens* the following bibliography: "Bet. pubescens Ehrh. Beitr. z. Naturk. VI. S. 98. 1793. . . . Bet. tomentosa Reitter u. Abel Abbild. d. 100 wild. deutsch. Holzart. I. 17. 1790." If Dippel's bibliography were correct, the name *B. tomentosa* ("1790") would obviously antedate *B.*

*pubescens* (1793). This, however, is not the case. It is simply one of the many errors which the incorrect citations of Reitter & Abel have started.

In the first place, the name of the first of the two authors has been so misinterpreted that one wonders if later authors have ever taken the trouble to look up the books. Thus, in Index Kewensis he appears as Retz[ius]. Von Hayek, Fl. Steyerm. i. 105 (1908), swallowed without evident choking the predigested date, 1790, and displaced *B. pubescens* (1793) by *B. tomentosa* "Reith et Abel"; and Schneider, Ill. Handb. Laubholzk. ii. 886 (1912) also said "Reith et Abel". Ascherson & Graebner, Syn. iv. 398, got nearer the facts as to the first author but by omitting a period made the authors and the place of publication erroneously appear as "Reitt u. Abel Abb. 100 wild. Holzart. I. 17 (1790)." Even the very careful Bradley Bibliography called them Reiter & Abel in vol. i. 370, but one looks in vain for them under Reiter in the Index, for there (vol. iv. 716) they are entered only under Reitter.

The author himself (or his editors, collaborators or publishers) was doubtful as to his own name. There were two quite different books by the pair of authors. In the citations by later authors these have been hopelessly confused. These books were

1. Abbildung der Hundert deutschen wilden Holz-Arten, etc. Stuttgart. 1790. With colored plates. The authors given as Reitter und Abel and the first author's name spelled in the dedication very definitely "Reitter". The somewhat altered second edition, with the dedication and much of the introductory matter omitted, the plates uncolored, came out in 1805. Here he appears as "Reiter".
2. Beschreibung und Abbildung der in Deutschland seltener wildwachsenden und einiger bereits naturalisirten Holz-Arten, etc. Stuttgart. 1803. The authors given as Reiter und Abel.

No. 1 alone was caught by Pritzel's Thesaurus. Since no. 2 was evidently unknown to Pritzel it must be very rare. I have, fortunately, been able to consult them both, as well as the 2nd edition of no. 1, at the Arnold Arboretum; and the Librarian, Mrs. Schwarten, kindly refers me to the biography of Johann Daniel Reitter in Hess, Lebensbilder, 287 (1885), the biographer there listing book no. 1, Abbild. Hundert deutsch. wild. Holz-Art., but not no. 2, Beschreib. und Abbild. Deutschl. Holz-Art. Now, when both these works are examined it will be found that in no. 1, Abbild. Hundert deutsch. wild. Holz-Art., there is no

*Betula tomentosa*. The only true Birch there is on p. 7 (not 17), "XV. *Kupfertafel*. Die *Birke*. Wonnerbaum. Betula alba"; while plate 15 has merely the text "*Betula alba. Die Birke*". Dippel, von Hayek and others who have started *B. tomentosa* there have obviously been mistaken.

In work no. 2, Beschr. und Abbild. 17 (1803) there is a detailed account of *Betula tomentosa*, the "wohlriechende Birke" and t. 15 shows it in color, also as *B. tomentosa*. That, however, was in 1803, not in 1790, so that for those who maintain *B. pubescens* as a species the name *B. tomentosa* offers no competition. The rarity of Reitter & Abel's Beschr. und Abbild. (1803) is further indicated by the absence of a reference to its plate 15 in Index Londinensis. Plate 15 of the Abbildung (1790) is there correctly cited under *B. alba*.

6. B. PAPYRIFERA Marsh. Arb. Am. 19 (1775). *B. papyracea* Ait. Hort. Kew. iii. 337 (1789). *B. alba*, δ. *papyrifera* Spach in Ann. Sci. Nat. Bot. sér. 2, xv. 188 (1841); Regel in Nouv. Mém. Soc. Sci. Nat. Mosc. xiii. 81—repr. Mon. Bet. 23—t. v. fig. 5–16 (1861). *B. alba* sensu Fernald in Am. Journ. Sci. ser. 4, xiv. 169 and 190, in small part (1902).—Highly variable; represented in eastern North America by the following varieties and forms,

*a*. Leaves merely rounded to tapering at base....*b*.
  *b*. Bracts of pistillate aments 3-lobed; peduncle usually shorter than fruiting ament; the latter 2.5–6.5 cm. long....*c*.
    *c*. Mature fertile bracts 3.5–7 mm. long, with divergent lateral lobes; samaras 3.5–5 mm. broad....*d*.
      *d*. Branchlets spreading or ascending, not strongly drooping; leaves of fertile branches broadly ovate, mostly rounded at base; pistillate aments mostly solitary on the spurs....*e*.
        *e*. Bark of trunks of fruiting trees (or shrubs) creamy- to pinkish-white, very soon exfoliating.
          Leaves membranaceous to firm, hardly lustrous ..... *B. papyrifera* (typical).
          Leaves thick and leathery, lustrous above..... Forma *coriacea*.
        *e*. Bark of fruiting trunks warm-brown, only on oldest bases with smooth outer brown layer exfoliating ..... Var. *commutata*.
      *d*. Branchlets pendulous; leaves of fertile branches narrowly ovate to ovate-lanceolate, only slightly rounded to gradually tapering to petiole; pistillate aments often in fascicles of 2–4 on the spurs..... Var. *pensilis*.
    *c*. Mature fertile bracts 7–10 mm. long, with ascending lateral lobes; samaras 6–8 mm. broad; leaves ovate, with rounded bases; fruiting aments solitary or paired.
      Peduncles of fruiting aments 0.5–1.5 cm. long, many times shorter than ament..... Var. *macrostachya*.
      Peduncles 2–3 cm. long, one half to essentially as long as pendulous ament..... Forma *longipes*.

*b.* Bracts unlobed or with merely rudimentary lateral lobes, elliptic-oblong; pistillate aments 1.5–2 cm. long, about equaled by arched-recurving peduncle; leaves rhombic-oval, dentate ..... Var. *elobata.*

*a.* Leaves definitely cordate at base; bracts of mature pistillate aments 5–10 mm. long, mostly with ascending lobes; bark of mature trunks warm-brown to creamy- or pinkish-white ..... Var. *cordifolia.*

B. PAPYRIFERA, typical.—Woods, especially on slopes, Labrador to Alaska, south to Newfoundland, Nova Scotia, New England, New York, upland of Pennsylvania and West Virginia, northern Ohio, northern Indiana, northern Illinois, northern Iowa, South Dakota, etc. PLATE 964.

Forma CORIACEA Fernald & Wiegand in RHODORA, xxv. 209 (1923)—Dunes of Lake Ontario, New York.

Var. **commutata** (Regel), comb. nov. *B. occidentalis* Hook. Fl. Bor.-Am. ii. 155 (1839) as to specimen from *Scouler* only, not as to other specimens and detailed description; sensu Lyall in Journ. Linn. Soc. vii. 134 (1864); sensu Sargent in Bot. Gaz. xxxi. 237 (1901); not Hook. l. c. as to detailed descr. (1839), nor Nutt. N. A. Syl. i. 23, pl. 7 (1853), nor S. Watson in Bot. King Report—U. S. Geol. Expl. 40th Parallel, v. 323, pl. xxxv (1871), nor Sargent, Sylva, ix. 65, pl. cccclv (1896), nor S. Wats. Bot. Calif. ii. 79 (1880). *B. alba,* subsp. *occidentalis* (Hook.) Regel, β. *commutata* Regel in Bull. Soc. Nat. Mosc. xxxviii. 401 (1865)—repr. as Bemerk. Gatt. Bet. Aln. 14, pl. 7, figs. 6–10 (1866) and in DC. Prodr. xvi$^2$. 166 (1868), as to TYPE from Sumass Prairie, *Lyall. B. papyracea,* var. *occidentalis* sensu Dippel, Handb. Laubholzk. 177 (1892). *B. Lyalliana* Koehne in Mitt. Deutsch. Dendr. Gesellsch. 1899: 53 (1899), *nomen only. B. alba,* forma *occidentalis* sensu Fernald in Am. Journ. Sci. ser. 4, xiv. 173 and 190 (1902), not *B. occidentalis* Hook. basonym. *B. papyracea Lyalliana* Koehne ex Schelle in Beisner, Schelle & Zabel, Handb. Laubh.-Ben. 55 (1903). *B. papyrifera,* var. *Lyalliana* (Koehne) Schneid. Ill. Handb. Laubhk. i. 115 (1904), based on "*B. occidentalis* LYALL, in Jour. Lin. Soc. VII. 134. *1864,* ex parte, non Hook." *B. papyrifera,* var. *occidentalis* sensu Sargent in Journ. Arn. Arb. i. 63 (1919), not *B. occidentalis* Hook. basonym.—Woodlands near the coast, Labrador to northeastern Massachusetts; western North America south to Oregon. PLATE 965.

In 1902 I pointed out that the character of permanently close and dark bark, which Sargent (1901) took as the single *specific* character of the tall tree of the Pacific slope, "perhaps the largest of all birch-trees" (Sargent, l. c. 238), breaks down in the West and that in the East trees, otherwise inseparable from *B. papyrifera,* may have the bark permanently quite as dark as in the tree

of Puget Sound and the lower Fraser River. Subsequently I have seen forests in Newfoundland and at the tip of the Gaspé Peninsula where the large trunks (up to 9 dm. in diameter) were covered with smooth deep-brown bark. In the oldest trees, however, the dark bark of the base of the trunk (up to 2 or 3 m.) will sometimes exfoliate and there leave perfectly characteristic exfoliating pale bark (PLATE 965, FIGS. 2 and 3) of typical *B. papyrifera*. One of the southernmost stations in the East seems to be on Cape Ann, large brown-barked shrubs loaded with fruit, near granite-quarries back of Bayview, Gloucester, where it was collected in August, 1944, by Miss Elizabeth Johnston. It might be thought that it was long ago recorded from Essex County, for the three specimens cited by Regel of his *B. alba*, subsp. *occidentalis*, β. *commutata* were from "Sumass Prairie (Lyall), Topsfield, Massachusetts (Asa Gray), Oregon (Lyall). The Topsfield specimen, labelled by Regel as above, was distributed by William Oakes as *B. papyracea;* Asa Gray merely sent it on loan to Regel. There is no note regarding the bark of the trunk; apparently Oakes did not see anything unusual in it. The Lyall specimen from Sumass Prairie is the TYPE of var. *commutata*.

Hooker, Nuttall, Torrey, Sereno Watson and many other careful students of the past correctly understood Hooker's rather vivid description of *Betula occidentalis*. Unfortunately, however, Hooker originally complicated matters by first citing a specimen from "Straits of De Fuca. *Dr. Scouler*", although his description was, it seems to me and to several field-botanists who know both trees, based almost entirely on the characteristic shrub or small tree of the Rocky Mountain region, west to the drier slopes of British Columbia, Washington, Oregon and California, the species which Sargent, l. c. 239 (1901) renamed *B. fontinalis*. These two trees are abundantly distinct but I am unable to follow Sargent's reasoning, except that in 1901 he was following the now abundantly discredited principle of neglecting, if it happened to disagree, the description and taking as type the first cited specimen, in this case the Scouler specimen from the Straits of Juan de Fuca. In doing so, however, he saw in Hooker's description more elements of that species than I can find and consequently set off the cordilleran *B. fontinalis*. He

stated that the specimens cited by Hooker came from three different trees:

First, *Betula papyrifera* Marsh . . .

Second, the large tree which grows on the lower Fraser river, on the shores and islands of Puget sound, and on Vancouver island (PLATE 965, FIGS. 1 and 4–6). This tree has . . . pubescent branchlets, . . . leaves pubescent on the lower surface, . . . Specimens of this tree, which is perhaps the largest of all birch-trees, were first gathered on the shores of the straits of Fuca by Dr. John Scouler . . . The tree from the straits of Fuca appeared first in the description of *Betula occidentalis which was evidently drawn principally from the specimen of that tree* [italics mine], and must be considered the type of Hooker's species . . .

Third, the half-shrubby dark-barked species . . . which ranges as far south as Colorado, Utah, and northern California. This plant was collected by Nuttall on the Sweetwater . . . and was first described and figured by him as *Betula occidentalis* (*Sylva* **I:** 23. *pl. 7*). Torrey in the Botany of Fremont's Expedition repeats this error. This same species was also described and figured in *King's Rep.* (**5:** 323. *pl. 35*) as *Betula occidentalis* by Watson who repeated his error in the *Botany of California*, and it . . . is described and figured as *Betula occidentalis* in my ninth volume of *The Sylva of North America* . . . our tree, for which I now propose the name of **Betula fontinalis.**

Along with many others I have fallen into the trap and have followed Sargent in calling the cordilleran low tree or coarse shrub *Betula fontinalis*. This course, as already stated, ignores the very definite description given by Hooker:

3. *B. occidentalis;* ramis rufo-fuscis copiose resinoso-verrucosis, foliis late rhombeo-ovatis sublobatis grosse inciso-serratis sub lente appresso-hirsutulis v. nudis subtus pallidioribus epunctatis, nervis paucis remotis, amentis foem. lato-cylindraceis, squamis lobis ovato-oblongis lateralibus decurvo-falcatis intermedio longiore.

HAB. Straits of De Fuca. *Dr. Scouler.* Near springs on the west side of the Rocky Mountains. *Douglas;* and on the east side, from the mountains to Edmonton House. *Drummond.* One specimen is in the collection from the Arctic coast* (?) *Dr. Richardson*—This Birch does not agree with any described species, and it is probably confined to the west coast, and to the immediate vicinity of the Rocky Mountains, forming a low, small brush-wood, 6–10 feet high, and never exceeding a few inches in the diameter of its trunk. Mr. Drummond considered it to be the *B. nigra*, but its bark and leaves are quite different; [Then a statement of characters of *B. nigra*]. The main branches are erect, and somewhat virgate, clothed with a red-brown bark, a little inclining to purple, copiously sprinkled with resinous warts in all the specimens. Petioles ½ to ¾ of an inch long, adult leaves 2–2½ inches, broadly ovato-rhomboid, rather acute than acuminate, of a harsh and dry but not thick texture, slightly lobed at the margin, and inciso-serrate, the serratures coarse and sharp, paler beneath, but never, either in the old or younger state, dotted. Male catkins resembling those of the preceding [*B. papyrifera*], 1–2 inches long.

"* There has probably been some mistake in the station of this."

In the two following paragraphs I have quoted the characters as described by Sargent, Man. 204, 205 and 207 (1905) and by Rydberg, Fl. Rky. Mts. 202–204 (1918) of *B. occidentalis* sensu Sargent (i. e. *B. papyrifera*, var. *commutata*) and *B. fontinalis* Sargent (i. e. *B. occidentalis* Hook.); and after each item Hooker's own description in italics. As Bateson used to say, a judicious advocate leaves the conclusion to flow quietly from the evidence.

B. OCCIDENTALIS sensu Sargent (i. e. B. PAPYRIFERA, var. COMMUTATA). "A tree, 100°–120° high, with a trunk 3°–4° in diameter" (*Sargent*); "tree sometimes 30–40 m. high" (*Rydb.*) HOOKER: "*small brush-wood, 6–10 feet high, and never exceeding a few inches in the diameter of its trunk*". The "branches often pendulous on old trees, . . . branchlets more or less glandular and coated with long pale hairs when they first appear, . . . marked by numerous minute pale lenticels and pubescent or puberulous during their first winter and nearly destitute of glands" (*Sargent*); "at first pubescent or puberulent" (*Rydb.*) *Hooker: "ramis . . . copiose resinoso-verrucosis", "The main branches erect, and somewhat virgate, . . . copiously sprinkled with resinous warts on all the specimens".* Leaves "ovate, acute, . . . covered with dark reddish resinous viscid glands, and villous along the midribs and veins, with long white hairs often also in large persistent tufts in the axils of the primary veins, and at maturity thin and firm in texture, marked by the scars of the fallen glands, . . . 3′–4′ long, . . . their petioles stout, glandular, at first tomentose, ultimately pubescent or puberulous, about ¾′ long" (*Sargent*). HOOKER: "*foliis late rhombeo-ovatis . . . sub lente appresso-hirsutulis v. nudis subtus . . . epunctatis" . . . "Petioles ½ to ¾ of an inch long, adult leaves 2–2½ inches, broadly ovato-rhomboid, rather acute than acuminate, of a harsh and dry but not thick texture, . . . paler beneath, but never, either in the old or younger state, dotted*". The "staminate aments . . . becoming 3′–4′ long" (*Sargent*). HOOKER: "*Male catkins . . . 1–2 inches long.*"

B. OCCIDENTALIS sensu Nuttall, Torrey, Sereno Watson and Sargent's Sylva (i. e. B. FONTINALIS Sargent): "more commonly shrubby, with many thin spreading stems forming open clusters, 15°-20° high; often much lower, and frequently crowded in almost impenetrable thickets" or more rarely "A tree, occasionally 30°-40° high, with a trunk 12′-18′ in diameter" (*Sargent*); "tree occasionally 10–12 m. high, often growing in clumps and shrub-like" (*Rydb.*). HOOKER: "*forming a low, small brush-wood, 6–10 feet high, and never exceeding a few inches in the diameter of its trunk.*" Branchlets "much roughened at first by large lustrous resinous glands persistent until the second season" (*Sargent*); "twigs densely glandular-resiniferous", "not hairy" (Rydb.). HOOKER: "*ramis copiose resinoso-verrucosis", "branches . . . copiously sprinkled with resinous warts in all the specimens*". Leaves "broadly ovate, acute" with "abruptly wedge-shaped . . . base, and sometimes slightly laciniately lobed, . . . pilose above, and covered by conspicuous resinous glands when they unfold, at maturity thin and firm, . . . 1′–2′ long, . . . petioles . . . ⅓′–½′ long" (*Sargent*); "leaves broadly ovate, usually less than 4 cm. long" (*Rydb.*). HOOKER: "*foliis late rhombeo-ovatis sublobatis grosse inciso-serratis sub lente appresso-hirsutulis v. nudis subtus . . . epunc'atis", "petioles ½ to ¾ of an inch long, adult leaves 2–2½ inches, broadly ovato-rhomboid, rather acute than acuminate, of a harsh and dry but not not thick texture, slightly lobed at the margin, . . . never, either in the old or younger state, dotted*". Staminate "aments . . . becoming 2′–2½′ long" (*Sargent*); "staminate aments 5–7 cm. long" (Rydb.). HOOKER: "*Male catkins . . . 1–2 inches long*".

When we take into account the facts that plenty of mature branches of *Betula occidentalis* (*fontinalis*) have leaves down to ¾ inch long and petioles down to less than ¼ inch in length, while others (*Koehne*, Herb. Dendrol. no. 105; *L. E. Smith*, no. 759; *Muenscher & Maguire*, no. 15,690; *M. E. Peck*, no. 9468; *F. A. Walpole*, no. 323; *Eggleston*, no. 21,998; *St. John*, no. 7655; show blades 2–2½ inches long, while in an extreme variety they may be up to 7 cm. long, it becomes quite clear that in most of his stated characters Hooker was accurately describing the relatively low and often shrubby species which Nuttall, Torrey, Watson and others understood as *B. occidentalis* and which Sargent, without any concrete diagnosis and without designation of type, called *B. fontinalis*.

Returning to *Betula papyrifera*, var. *commutata*, that name started as *B. alba*, subsp. *occidentalis*, var. β. *commutata* Regel in 1865, Regel defining his subsp. *occidentalis*, var. α. *typica* "trunco humili, foliis inciso-sublobatis dentatisque" (i. e., following Hooker's original description), while his var. *commutata* was defined as follows:

> β *commutata* (tab. 7, fig. 6–10); trunco elato, foliis duplicato-dentatis.—Als B. papyracea und papyrifera im Herbarium Asa Grays und Boissiers.—Wächst in Nord-amerika, Sumass Praierie (Lyall), Topsfield, Massachusets (Asa Gray), Oregon (Lyall).
>
> Von der folgenden Unterart [papyrifera] nur durch die gespreizten oder zurück gekrümmten Seitenlappen der Schuppen des Fruchtzäpfchens verschieden.

All three sheets, including the TYPE from Sumass Prairie are before me. In all evident characters they are quite like the tree of the Pacific slope which Sargent took as *B. occidentalis* and they are all easily matched in details by much eastern *B. papyrifera*. The tree of the Fraser River region, including Sumass Prairie, is with reasonable certainty the dark-barked variety, but the Topsfield specimen of William Oakes (not Asa Gray) is, as already explained (p. 313) evidently from the pale-barked and generally commoner eastern *B. papyrifera*. In Lyall's account of "The Lower Fraser River district, which includes the Sumass and Chilukweyuk prairies and other low grounds to the westward of the Cascade Mountains—a moist region", Lyall, in Journ. Linn. Soc. Lond. vii. 131–135 (1864), enumerated from "The banks of the Lower Fraser River . . . *Abies Douglasii*, . . .

*Abies Menziesii*, ". . . *Abies Mertensiana*, . . . *Thuja gigantea*, . . . *Acer macrophyllum*", etc. and then "*Betula occidentalis*, Hook. (a tree growing to the height of 60 or 70 feet [compare Sargent's "100°–120°", also J. K. Henry's "A small or large tree"] and most common about the borders of the forest)". That material was the basis of var. *commutata*. When Schneider published his *B. papyrifera*, var. *Lyalliana*, citing the Lyall account above quoted and the synonym *B. occidentalis* sensu Sargent, not Hooker, he evidently overlooked the earlier name which had been based on the Lyall collections.[1]

[1] The reinstatement of *Betula occidentalis* Hook. necessitates the following new varietal name.

B. OCCIDENTALIS Hook., var. **fecunda**, nom. nov. *Betula*, 3d. described tree in Piper & Beattie, Fl. Palouse Reg. 55 (1901). *B. Piperi* Britton in Bull. Torr. Bot. Cl. xxxi. 165 (1904), as to description, not as to single collection cited. *B. fontinalis*, var. *Piperi* (Britton) Sargent in Journ. Arn. Arb. i. 65 (1919), in part only. PLATE 966.

In their Flora of the Palouse Region Piper & Beattie, with well-understood hesitation, refrained from assigning guesswork names to the three birches of the area. Instead, they described the three in detail but without names. Their third tree was "B. Graceful tree, 8–15 m. tall, with drooping branches: bark dark bronze . . . branchlets . . . very glandular; leaves ovate, obtuse or acute at the base, . . . shining green above, glandular on both surfaces, 2–4 cm. long . . . : pistillate aments cylindrical: 5 cm. long, .5 cm. thick, often flexuous, mostly in twos, . . . Springy hillsides near Almota."

This description was but slightly, though somewhat, changed by Britton, whose *B. Piperi* was the "tree . . . described by Professor Piper as attaining a height of 15 m. and being slender and graceful, with drooping branches" &c., largely a rewriting of the Piper & Beattie description above quoted. But, most unfortunately, the locality of the "Graceful tree, 8–15 m. tall, with drooping branches", "Springy hillsides near Almota", was not given. Instead, Britton cited only a single station: "Type collected by Professor C. V. Piper, July 9, 1901, nine miles south of Pullman, Washington", with the sad result that Piper himself, accepting for the tree which I am calling *B. papyrifera*, var. *commutata* Sargent's misidentification of it as *B. occidentalis* Hook., was forced to reduce *B. Piperi* to its synonymy. Piper's statement follows: "The name *Betula piperi* was meant by its author to apply to the third unnamed species in the Flora of the Palouse Region, but the specimen actually cited is the eastern Washington form of *B. occidentalis* Hook."—Piper, Fl. Wash., Contrib. U. S. Nat. Herb. xi. 218 (1906).

Var. *fecunda* (PLATE 966) is a remarkably definite variety of the western *Betula occidentalis* (*fontinalis*). In its pendulous branches with the tendency to fascicled and slender aments it is strikingly unlike the shrubby and virgate-branched *B. occidentalis* of Hooker's original description, in which the shorter aments are mostly solitary on the spurs. The latter has been so often illustrated that I am here showing only var. *fecunda*. Piper, puzzled by this beautiful tree, sent, unnamed, 14 sheets (under several numbers) to the Gray Herbarium. These were mostly misidentified by me as the Asiatic *B. microphylla*. Under this misidentification of mine Piper in his Flora of Washington, p. 219, wrote: "The Almota specimens form the basis for the third unnamed species in the Flora of the Palouse Region. This is a tall graceful tree with drooping branches, appearing very different from the ordinary form of *B. microphylla*, and probably distinct from it." As TYPE of var. *fecunda* I am designating *Piper*, no. 1642 in the Gray Herbarium.

Although the leaves of var. *fecunda* were described by Piper as 2–4 cm. long, his material was all rather young. Material from slightly to the southwest, Columbia Co., *St. John, Davison & Scheibe*, no. 6939, has leaves 5–7 cm. long.

Var. **pensilis,** var. nov. (TAB. 967), ramulis pendulis; foliis angusto-ovatis vel ovato-lanceolatis basin versus plerumque angustatis vel vix rotundatis; amentis foemineis solitariis vel 2–4-fasciculatis; bracteis 5.5–7 mm. longis, lobis lateralibus rhomboideis vel late oblongis divergentibus. *B. alba* var. *glutinosa* sensu Fernald in Am. Journ. Sci. ser. 4, xiv. 176 (1902), not Trautv.—Locally abundant, Newfoundland to western Quebec, south to Nova Scotia, Maine, Massachusetts and northern New York. NEWFOUNDLAND: high tableland, Holyrood, Aug. 1, 1931, *Agnes M. Ayre;* Buchan Junction, July 19, 1930, *K. P. Jansson.* QUEBEC: Rivière du Brick, Anticosti, *Victorin & Rolland,* no. 27,773; thickets and borders of woods near mouth of Marsouin River, Gaspé Co., *Fernald & Pease,* no. 25,017; head of l'Anse aux Bouleaux, Bic, Rimouski Co., July 6–10, 1905, *Williams, Collins & Fernald;* Bic, July 17, 1905, *J. R. Churchill;* east side of Lac Tremblant, Terrebonne Co., July 21, 1922, *Churchill;* near Georgeville, Lake Memphremagog, Aug. 12, 1914, *Churchill.* NOVA SCOTIA: "small tree 10 ft. high, branches drooping", banks of Lahave R., Bridgewater, *J. G. Jack,* no. 3510. MAINE: tree by road to Leighton Pond, Pembroke, July 10, 1909, *Fernald* (TYPE in Herb. Gray.); by Wassataquoik River between Roebar's and Dacy Dam, Piscatquis Co., July 17, 1900, *Fernald.* MASSACHUSETTS: large tree by Charles River, Newton Lower Falls, July 23, 1912, *Wiegand.* NEW YORK: banks of Cascade Lakes, Essex Co., *House,* no. 7640; mountain-side, alt. 1800 ft., near Minerva, Essex Co., *House,* no. 14,887; Stony Island 2, west end of Black Lake, St. Lawrence Co., *Muenscher & Maguire,* no. 2168.

Var. *pensilis* is very striking, not only as a "weeping" birch but on account of the mostly acute-based leaves and the very abundant fruiting aments. In 8 of the sheets before me they are often clustered on the spurs in fascicles of 2–4.

Var. **macrostachya,** var. nov. (TAB. 968, FIG. 1–3), ramulis divergentibus vix pendulis; foliis ovatis basi rotundatis; amentis foemineis solitariis vel binis, maturis 3.5–5.5 cm. longis 1–2 cm. crassis pedunculatis; pedunculis arcuato-recurvatis 0.5–1.5 cm. longis; bracteis 7–10 mm. longis, lobis lateralibus rhomboideis porrectis vel adscendentibus; samaris 6–8 mm. latis.—Local, northern Newfoundland to Rimouski County, Quebec, south to Nova Scotia and northern Maine. NEWFOUNDLAND: rich thickets on lower slopes of Ha-Ha Mt., Ha-Ha Bay, *Fernald, Wiegand, Long, Gilbert & Hotchkiss,* no. 28,065; thickets and glades, slopes of Cape Dégrat, Quirpon Island, Straits of Belle Isle, *Fernald & Long,* no. 28,067. QUEBEC: cold northerly calcareous walls of Grande Coupe, Percé, Gaspé Co., *Fernald & Collins,* no. 1000; bois près de la mer, Bic, Rimouski Co., *Victorin & Rolland,* no. 49,461. NOVA SCOTIA: dry mixed woods, Hecta-

nooga, Digby Co., July 31, 1920, *Long & Linder*, no. 21,007 (TYPE in Herb. Gray.; ISOTYPE in Herb. Phil. Acad.). MAINE: in disintegrated volcanic rock, Haystack Mt., Aroostook Co., July 11, 1902, *Williams, Collins & Fernald.*

In its very large aments, bracts and samaras var. *macrostachya* stands midway between typical *Betula papyrifera* and var. *cordifolia*. It is also intermediate in the tendency of its pistillate bracts to have the porrect lateral lobes of the latter, but sometimes nearly or quite horizontal as in the former. Its leaves are like those of typical *B. papyrifera*, without the cordate base so characteristic of var. *cordifolia*. Were it not for this transitional var. *macrostachya*, it would be reasonable to look upon var. *cordifolia* as a fairly distinct species, the status originally given it by Regel.

Var. MACROSTACHYA, forma **longipes,** f. nov. (TAB. 968, FIG. 4), pedunculis 2–3 cm. longis, amentis fructiferis pendulis.—Gaspé Peninsula, QUEBEC: woods, Malbaie, Gaspé Co., *Pease,* no. 6025A, as var. *cordifolia;* mossy meadows and woods at 455 m. (1500 ft.)—915 m. (3000 ft.) in the great basin [Fernald Basin] under the north slope of Mt. Logan, Matane Co., July 22, 1922, *Fernald & Pease,* no. 25,019 (TYPE in Herb. Gray.).

Very striking in its long drooping peduncles often essentially as long as the pendulous aments.

Var. ELOBATA (Fernald) Sargent in Journ. Arn. Arb. i. 63 (1919). *B. alba*, var. *elobata* Fernald in RHODORA, xv. 169 (1913).—Known only from the type-locality in QUEBEC: crevices and talus of serpentine along Ruisseau à la Neige, Mt. Albert, Gaspé Co., *Fernald & Collins*, no. 531. PLATE 969.

It is not improbable that var. *elobata*, when mature fruiting material is secured, may prove to be an endemic species. In its subrhombic and dentate leaves, suggestive of those of *B. nigra* L., and in its very short pendulous pistillate aments with unlobed or only obsoletely lobed bracts, it is very distinct. Unfortunately, the material, collected in an alpine area and only slightly past anthesis in July, does not show mature samaras. The type-colony is near the head of one of the northwestern tributaries of Ruisseau à la Neige, as it abruptly descends the cañon-wall, not far below the serpentine tableland (alt. about 3500 ft.). Under it grow *Polystichum mohrioides*, var. *scopulorum* (D. C. Eaton) Fernald, in its only known area east of local stations in Idaho, while close-at-hand are the type-areas of the endemic or near-

endemic *Salix chlorolepis* Fernald, *S. hebecarpa* Fernald, *Arenaria marcescens* Fernald and *Solidago chlorolepis* Fernald, and endemic or disjunct varieties in *Salix*, *Statice* and *Cnicus*. It is important to secure the fruit of *Betula papyrifera*, var. *elobata*.

Var. CORDIFOLIA (Regel) Fernald in RHODORA, iii. 173 (1901), by inference only; Rehder, Man. Cult. Trees and Shrubs, 141 (1927). *B. cordifolia* Regel in Nouv. Mém. Soc. Nat. Mosc. xiii. 86—repr. as Mon. Bet. 28, t. 12, figs. 29–36 (1861). *B. alba*, subsp. *papyrifera*, β. *cordifolia* (Regel) Regel in Bull. Soc. Nat. Mosc. xxxiii. 401 (1865)—repr. as Bemerk. Gatt. Bet. Aln. 14 (1866) and in DC. Prodr. xvi². 166 (1868). *B. papyracea*, a *cordifolia* (Regel) Dippel, Handb. Laubholzk. ii. 177 (1892). *B. alba*, var. *cordifolia* (Regel) Fernald in Am. Journ. Sci. ser. 4, xiv. 177 and 190 (1902). *B. papyracea cordifolia* (Regel) Scheele in Beisn., Scheele & Zabel, Handb. Laubh. Benen. 55 (1903). *B. papyrifera*, var. *communis*, f. *cordifolia* (Regel) Schneid. Handb. Laubholzk. i. 115 (1904).—Labrador to Algoma District, Ontario, south to Newfoundland, Nova Scotia, New England (rare southward), northern New York, Michigan, Wisconsin and northern Iowa; high altitudes on Blue Ridge, North Carolina. PLATE 970.

In its firm and definitely cordate leaves, its long bracts with mostly porrect lobes and its large samaras *Betula papyrifera*, var. *cordifolia* might merit the specific rank originally given it by Regel; but, as already noted, var. *macrostachya*, with leaves merely rounded and not cordate at base, exactly bridges the gap between it and typical *B. papyrifera*. With its very long bracts with mostly porrect (instead of horizontally divergent) lobes it is certainly a well marked geographic variety, which in the western half of the continent is replaced by var. *subcordata* (Rydb.) Sargent. Rare in southern New England and not known south of the Adirondack region in New York, this is the only variety of *B. papyrifera* known on the high mountains of North Carolina. In discussing its discovery and abundance at 5500–6200 ft. altitude, "in the spruce and balsam forest", "about 550 miles" south of its supposed southern limit (in Massachusetts and Connecticut), Ashe in RHODORA, xx. 63, 64 (1918) quoted various northern botanists, some of whom (Britton and Blanchard) regarded it a good species, others (Sargent and Burns, besides the present writer) recognizing intergradient trees; and be concluded: "The fact that the cordate [-leaved] form alone occurs in North Carolina, and that there its leaf-form is strongly marked and

without indication of variation—foliage was examined from more than 100 trees—would at least seem to give it excellent varietal if not specific characterization."

In his original publication of *Betula cordifolia* Regel cited it as in "Novaja Semlaja von Hr. de la Tylaie im Jahre 1826 gesammelte" and compared it with the Asiatic *B. Ermani* Chamisso, arguing for its specific separation since "dass B. Ermani bis jetzt aus Novaja Semlaja noch nicht bekannt ist". Bearing in mind that Novaja Semlaja is the Russian equivalent of Terre-neuve, where Bachelot de la Pylaie (not "Tylaie") spent so many years in botanizing, the intent is obvious. In fact, Regel got the type-locality straightened in his later treatments, where he correctly gave it as "Terra nova (de la Pylaie . . . )."

A small-leaved northwestern variety of *Betula papyrifera*, which may be expected to cross the plains into Minnesota, has leaves in outline resembling those of *B. pendula*. This is

B. PAPYRIFERA Marsh., var. **humilis** (Regel) Fernald & Raup, comb. nov. *B. alba*, subsp. *papyrifera*, var. γ *humilis* Regel in DC. Prodr. xvi. 166 (1868), in part (descr. and Bourgeau specimen from Saskatchewan). *B. alaskana* Sargent in Bot. Gaz. xxxi. 236 (1901), not Lesq. (1883). *B. neoalaskana* Sarg. in Journ. Arn. Arb. iii. 206 (1921). *B. papyrifera*, var. *neoalaskana* (Sarg.) Raup, Contrib. Arn. Arb. vi. 152 (1934). PLATES 971 and 972.

*Betula alba*, subsp. *papyrifera*, γ. *humilis* was based primarily on a sheet in the Gray Herbarium, collected by Bourgeau in 1857–8 in Saskatchewan ("Bords de la rivière Castor"). This sheet (our PLATE 971, FIGS. 1–4) bears Regel's annotation. Although Regel followed this with citation of Parry and Hall & Harbour specimens, which are of *B. occidentalis* Hook. (*B. fontinalis* Sarg.) and the type of Tuckerman's *B. papyracea*, var. *minor* (*B. minor*) from the White Mts., his description, "folia . . . juniora petiolique saepe pubescentia, . . . subtus ad nervos tantum pilosula. Samararum alae nucula usque triplo latiores", definitely applies to the *Bourgeau* sheet. It can not apply to *B. minor*, for the branchlets and leaves of that more eastern shrub are strictly glabrous and the wings of its samaras are never "nucula usque triplo latiores". Nor could the glabrate branches of Regel's "Ramuli . . . glanduliferi v. juniores pubescentes, dein glabrati" apply to either *B. minor* or *B. occi-*

*dentalis*, both of which have glabrous branchlets; the "juniores pubescentes, dein glabrati" belongs also to the Bourgeau element. Since this Saskatchewan specimen, clearly labelled by Regel as his *B. alba*, subsp. *papyrifera*, var. *humilis*, agrees with his description in the more diagnostic characters, whereas the Rocky Mountain specimens (*Parry* and *Hall & Harbour*) as well as the White Mountain one (*Tuckerman*) already had legitimate names, we see no way but to take up the name var. *humilis* for the Saskatchewan element primarily described.

There is a second sheet of Bourgeau's Saskatchewan material (1858) in the Gray Herbarium. This one (PLATE 972, FIG. 1) has had a checkered career. In his Bemerkungen über die Gattungen Betula und Alnus, Bull. Soc. Nat. Mosc. xxxviii. 398 (1865)—repr. 11 (1866)—Regel published under the strictly Eurasian *Betula alba*, subsp. *verrucosa*, a var. *resinifera*, based exclusively on a Middendorf specimen from eastern Siberia. In DeCandolle's Prodromus, xvi$^2$. 164 (1868), however, although otherwise holding his *B. alba*, subsp. *verrucosa* strictly to Eurasia, he cited under var. *resinifera* a single North American specimen: "in America boreali-occidentali ad Saskatchevan (Palliser)". This specimen, *Bourgeau*, 1858, on the Palliser Expedition (Gray Herb.), was originally distributed as *B. papyracea* but it bears Regel's annotation as above. A portion of it is shown in PLATE 972, FIG. 1. The significant point in connection with this second *Bourgeau* (*Palliser*) sheet is that Sargent, describing his *B. alaskana*, selected it as the first specimen to be cited under his new specific name: "Saskatchewan, *E. Bourgeau*, 1858 (in Herb. Gray); near Prince Albert in latitude 53, July 1876, *John Macoun* [our PLATE 971, FIG. 5 and 972, FIGS. 2 and 3]; northwestward, reaching the Alaskan coast", etc. Of this *Bourgeau* specimen Sargent wrote: "The specimen in Herb. Gray collected by Bourgeau in flower on the Saskatchewan was referred by Regel (*Bull. Mosc.* **18:** 398; *DC. Prodr.* **16$^2$:** 164) to his *Betula alba*, subspecies *verrucosa* δ *resinifera*". The fact that, in spite of Sargent's statement, Regel did not mention the Bourgeau specimen in his first publication (Bull. Mosc.) but only in the second (DC. Prodr.) is significant; otherwise it might be involved in the typification of his *B. alba*, subsp. *verrucosa*, var. *resinifera* which, fortunately, was based solely on the Middendorf material.

The name *B. alba*, subsp. *papyrifera*, var. *humilis* has the right-of-way.

7. B. BOREALIS Spach in Ann. Sci. Nat. sér. 2, xv. 196 (1841). *B. pumila*, γ. *borealis* (Spach) Regel in Nouv. Mém. Soc. Nat. Mosc. xiii. 113—repr. Mon. Bet. 55, t. 13, figs. 38 and 39 (1861) and in DC. Prodr. xvi². 173 (1868). *B. alba*, var. *carpatica* sensu Fernald in Am. Journ. Sci. ser. 4, xiv. 179 and 190 (1902) in part only, not *B. carpatica* Wald. & Kit. *B. microphylla* sensu Eames and sensu Fernald, as quoted by Eames, in RHODORA, xi. 93 (1909), not Bunge.—Southern Labrador to James Bay, Ungava, south, chiefly on calcareous or magnesian soils to Newfoundland, Anticosti Island and Gaspé Peninsula, Quebec, and very rarely to Cape Breton and to northern Vermont.—Since this characteristic and very definite northeastern species has not been understood during the full century since Spach very clearly described it as "Legit cl. de Lapylaie, in insulâ Terrae-Novae" (this later rendered by Regel "von Herrn de la Tylaie in Novaja Semlaja gesammelt"), it is important to cite and illustrate good material (all, unless noted, distributed erroneously as *B. microphylla* Bunge). LABRADOR: common on many barrens and hillsides, Backway, off Lake Melville, *R. H. Wetmore*, no. 102,930. NEWFOUNDLAND: 1 m. high, peaty limestone barrens, southern half of Burnt Cape, Pistolet Bay, *Fernald & Long*, no. 28,070; cool springy glade, Burnt Cape, *F. & L.*, no. 28,075; limestone barrens on the Highlands northeast of Big Brook, Straits of Belle Isle, *Fernald, Wiegand & Hotchkiss*, no. 28,072; shrubs 1–2 m. high, spruce woods and thickets bordering limestone barrens, Brig Bay, *Fernald, Long & Dunbar*, no. 26,596; spruce woods and thickets, St. Barbe, *F. L. & D.*, no. 26,595; 1–2 m. high, thickets along East Brook, St. Barbe Bay, *Wiegand & Hotchkiss*, no. 28,080; slaty gorge of brook below serpentine barrens above Woody Point, Bonne Bay, *R. H. Kimball*, no. 117; 1–2 ft. high, quartzite gravel and talus, Killdevil, *Fernald, Long & Fogg*, no. 1636; gravelly beach, Middle Birchy Pond, Eastern Drainage of Humber R., *Fernald & Wiegand*, no. 3247 (as *B. alba*, var. *carpatica*); coarse shrub, southerly slopes of dry serpentine ridge, North Arm, Bay of Islands, *Long & Fogg*, nos. 217 and 219; dry thicket on exposed slope at about 1650 ft., Blow-me-down Mt., *Eames & Godfrey*, no. 6033; serpentine and magnesian limestone barrens, northeastern base and slopes of Blomidon ("Blow-me-down") Mts., *Fernald & Wiegand*, nos. 3245 (as *B. alba*, var. *carpatica*) and 3246; large shrubs, dry limestone barrens, upper slopes and tablelands, alt. 200–300 m., Table Mt., Port-à-Port Bay, *Fernald & Wiegand*, no. 3250 (as *B. alba*, var. *carpatica*), also *Fernald & St. John*, no. 10,827; coarse shrub, thickets on gneiss ledges along Grandy Brook, Distr. of Burgeo and La Poile,

*Fernald, Long & Fogg*, no. 218; springy and boggy places in river-gravel, Gander R., Glenwood, *Fernald & Wiegand*, no. 5308 (as *B. alba*, var. *carpatica*); gravelly river-bank, Glenwood, *F. & W.*, no. 5309 (as *B. alba*, var. *carpatica*). QUEBEC: 4 ft. high, rocky crest, Pointe au Maurier, Charnay, Saguenay Co., *St. John*, no. 90,385; granite hills, Mingan, *St. John*, no. 90,384; limestone sea-cliffs, Ile Ste. Généviève, Mingan Ids., *St. John*, no. 90,830; sur les rivages calcaires près du Lac Salé, Ile St.-Charles, Archipel de Mingan, *Victorin & Rolland*, no. 18,881; bordant le sommet de l'escarpement, Ile Nue, Mingan, *V. & R.*, no. 24,728; rivages, Ile à la Chasse, Mingan, *V. & R.*, no. 24,740 (as *B. glandulosa*); wet places, Becscie R., Anticosti, Sept. 7, 1883, *J. Macoun;* le long des platières calcaires, Rivière à la Patate, Anticosti, *Victorin, Rolland & Louis-Marie*, no. 21,726; à une douzaine de milles de l'embouchure, R. Jupiter, Anticosti, *Victorin & Rolland*, no. 24,729; arborescent, sur le bord de la falaise boisée, le long du portage de la ligne, Sand-top, Anticosti, *V. & R.*, no. 27,775; crevices and talus of serpentine, Ruisseau à la Neige, Mt. Albert, Gaspé Co., *Fernald & Collins*, no. 532; large shrub, steep clay banks of Matane R., Matane, *Fernald & Pease*, no. 25,022; Rupert House, James Bay, *D. Potter*, no. 805. NOVA SCOTIA: low thicket in bog on plateau north of Bay St. Lawrence, Victoria Co., *Roland*, no. 41,354 (as *B. pumila*). VERMONT: rock-outcrop, shore of Fairfield Pond, alt. 550 ft., Fairfield, Franklin Co., *S. F. Blake*, no. 3105 (as *B. alba*, var. *minor*); summit of Mt. Mansfield, July 2, 1897, *Kennedy, Williams* (as *B. papyrifera*, var. *minor*), July 23, 1901, *T. O. Fuller* (as *B. papyrifera*, var. *minor*). PLATE 973.

*Betula borealis* was very fully and clearly described by Spach, whose description is worth repeating:

> B. BOREALIS Nob.—Legit cl. de Lapylaie, in insulâ Terrae-Novae; forsàn varietas *Betulae excelsae* v. *Betulae albae*.
>
> Arbor? vel frutex? Rami haud resinoso punctati: novelli tomentosi. Folia floralia 6–15 lineas longa, ovato-v. obovato-v. lanceolato-v. oblongo-rhombea, acuta, subaequaliter serrato-dentata, basin versùs integerrima, brevè petiolata: juniora pubescentia; adulta subtùs glaucescentia, sparsè punctulata, reticulata, praeter nervos glabra. Stroboli subpollicares, erecti (?), brevè pedunculati, cylindracei, graciles; rachi gracili, ferè filiformi; squamis tricarpis cuneiformibus, subciliolatis, samaras obtegentibus, trilobis: lobis obtusis, aut subaequalibus, oblongis, nunc parallelis, nunc divergentibus, aut dissimilibus: lateralibus subfalcatis, deflexis, terminali abbreviato, subovato. Samarae ovatae v. suborbiculares, vix lineam latae, angustè alatae, squamis duplò brevioribus. (V. s. sp. in Herb. Mus. Par.)

The densely tomentulose pubescence of vigorous new shoots, usually without glandular atoms, the elliptic to somewhat

rhombic or ovate merely acute or acutish leaves more or less pubescent beneath, and the small samaras with the wings scarcely broader than the achene, clearly distinguish it from the other dwarf species of the *Albae* in the Northeast: *B. minor*. There is little to induce one who knows *B. pumila* to place it with that, as was finally done by Regel. The identification with the Siberian *B. microphylla* Bunge was a very crude mistake, quite as unclarifying as my reduction to the latter of the cordilleran North American *B. occidentalis* Hook. (*B. fontinalis* Sargent).[1] *B. microphylla*, as originally described and as represented by Altai material sent by Regel to Gray and perhaps isotypic (PLATE 963, FIGS. 8–10), as well as by more modern specimens, has the small obovate leaves with entire cuneate bases, the summit only coarsely dentate; its branchlets are covered with resinous warts and the wings of its samaras (PLATE 963, FIG. 10) are as originally described by Bunge "semen longitudine et latitudine superantibus." In *B. borealis* the acute or acutish leaves are toothed to base, the branchlets rarely glutinous and the wings of the samara narrow. *B. occidentalis* (*B. fontinalis*), although having broadly winged samaras and very gummy but glabrous branchlets and leaves, has the latter of firmer and heavier texture, more regularly serrulate or doubly serrate margins and usually an ovate outline and lingering pubescence on the upper surface. It does not well match true *B. microphylla* and is quite distinct from the eastern *B. borealis* and *B. minor*, the former with new branchlets heavily pubescent, and the samaras with very narrow wings, the latter glabrous from the first, with more slender fruiting aments and narrower samaras (2.5–5, av. 3.5, mm. broad), whereas the western *B. occidentalis* has the aments thick and the samaras 4–6, av. 5.2, mm. broad.

In *Betula*, ser. *Humiles*, two species need special discussion. The first is only doubtfully a member of this series, a tree of the mountains of western Virginia:

B. **uber** (Ashe), stat. nov. *B. lenta*, var. *uber* Ashe in RHODORA, XX. 64 (1918). PLATE 974, FIGS. 1–5.

It is most difficult to feel that the low tree ("20–25 ft. high", according to Ashe's label) described by Ashe as a small-leaved

[1] See discussion, pp. 313–317.

variety of *Betula lenta* has much, except aromatic bark, to do with that species. *B. lenta* (figs. 6 and 7) has cordate-ovate and long-acuminate leaves with fine and sharp serrulation and 10–20 pairs of veins impressed into the upper surface (a typical member of series *Costatae*). *B. uber*, on the other hand, as shown by isotypes at the Gray Herbarium and the Arnold Arboretum, has very short and broadly rounded, often nearly orbicular leaves with few coarse dentations and with only 3–6 pairs of veins not impressed above (characteristics of series *Humiles*). Furthermore, the pistillate aments are more slender than in *B. lenta* and the bracts end in low and broad lobes, those of *B. lenta* more elongate, with the middle lobe prolonged.

In describing his *B. lenta*, var. *uber* Ashe made no note of its size and he stated that the material, in young fruit and foliage, was collected on "Banks of Dickey Creek, Smyth County, Virginia, south of Rye Valley Station, January 14, 1914". The isotype deposited in the Gray Herbarium has Ashe's label, stating that the tree is "20–25 feet high" and that it was collected "At 2800 ft., June [not January], 1914". It is very important to learn much more about *B. uber*,—whether it is shrubby, the range of variation of foliage, the characters of the staminate aments, and its abundance and range.

Michauxii Spach . Rhod. 52: 25-33, 1950.

B. **terrae-novae**, sp. nov. (tab. 975, fig. 1–4), planta habitu *B. nanae;* ramis novellis tomentosis; foliis late cuneato-flabelliformibus coriaceis glabris valde reticulatis inciso-dentatis basin versus integerrimis; strobilis sessilibus 0.5–1 cm. longis; strobili squamis integerrimis vel subintegerrimis oblongis vel oblongo-lanceolatis vel oblongo-ovatis arcte adpressis apice subsquarrosis; nuculis ovoideis vel subrotundatis apteris margine incrassato.—*B. Michauxii* Spach in Ann. Sci. Nat. sér. 2, xv. 195 (1841), as to description, not as to Michaux plant, basis of the name. *Apterocaryon Michauxii* (Spach) Opiz in Lotos, v. 258 (1855), in part, not *B. nana* sensu Michx., basis of name. *B. nana*, ε *Michauxii* (Spach) Regel in Nouv. Mém. Soc. Nat. Mosc. xiii. 103—repr. Mon. Bet. 45 (1861), excluding Michaux plant, source of name.—Bogs, tundra and peaty, acidic barrens, Newfoundland and adjacent southeastern Labrador Peninsula. Type from diorite tableland, altitude about 550 m., northern region of the Blomidon ("Blow-me-down") Mts., Newfoundland, Aug. 22, 1910, *Fernald & Wiegand*, no. 3271, as *B. nana*, var. *Michauxii* (in Herb. Gray.).

It is unfortunate that the name *Betula Michauxii* had so con-

true B. nana L. is on Iceland, Greenland, Baffinland, Hudson Bay, Alaska.

fused a start. The tiny shrub of Newfoundland, southeastern Labrador and the extreme eastern end of the Côte Nord of Quebec is very distinct from the arctic *B. nana* (FIGS. 5–7) in its tomentose (instead of cinereous-puberulent) branchlets, its more flabelliform, more incised and more strongly reticulate leaves, and above all in simple instead of prominently 3-lobed pistillate bracts and its thick-margined, instead of definitely winged samaras. Spach gave a good description of it in general, but his "Strobili 4–8 pollices [inches] longi" was most unfortunate for any American birch and emphatically for a dwarf with strobiles only 5–10 mm. long! For his *B. Michauxii* Spach set up the new section *Apterocaryon*, which was clearly based on Newfoundland material: "Nuculae apterae, margine incrassato, intus suberoso, cinctae.—Squamae strobilae semper 1-carpae, integerrimae, nuculis duplo angustiores", and this was taken up as the genus *Apterocaryon* (Spach) Opiz. Further to confuse matters Spach started his description of the Newfoundland shrub: "B. MICHAUXII Nob.—*Betula nana* Michx.! Flor. Bor. Amer. (excl. syn.)" and gave the range "America borealis [derived from Michaux] et insula Terrae Novae [La Pylaie material at Paris, presumably]". The name *B. Michauxii* automatically belongs with the Michaux element which came from at least 650 miles farther west ("in sphagnosis, a sinu *Hudsonis* ad lacus *Mistassins*") than the western known limit of *B. terrae-novae*. Furthermore, the description of *B. nana* sensu Michx. Fl. Bor.-Am. 180 (1803), nomenclatural type of *B. Michauxii*, was of something quite different: the shrub "glaberrima" (instead of with tomentose branchlets); "amenti squamis profunde 3-partitis, laciniis oblongis" (instead of entire or merely with obscurely undulate margin); "capsulis orbiculatis, subapteris" (instead of quite apteris). Just what Michaux got we cannot learn at the moment. His description suggests one of the dwarf and glabrous or glabrescent extremes of *B. pumila* L., such as var. *renifolia* Fernald, which abounds on much of the Labrador Peninsula and in Newfoundland and which, in exposed situations, may become a tiny depressed mat with round-obovate to reniform leaves down to 8 mm. long and either pubescent or glabrous. Michaux's plant was, obviously, not at all the characteristic little shrub of the Newfoundland barrens.

The fact that Regel confused *Betula Michauxii*, as a variety,

with *B. nana* carries little weight. At the same time he also reduced *B. glandulosa* Michx. to his all-inclusive *B. nana*, as he likewise included the utterly different *B. borealis* Spach (our PLATE 973).

## Explanation of Plates

PLATE 963, FIGS. 1–7, BETULA MINOR (Tuckerm.) Fernald: FIG. 1, portion of TYPE, × 1; FIG. 2, fruiting branch, × 1, from Oakes Gulf, Mt. Washington, New Hampshire, *Eggleston*, no. 2676; FIG. 3, staminate aments, × 1, from Mt. Washington, New Hampshire, *Greenman*, no. 1087; FIG. 4, lower surface of leaf, × 5, from no. 2676; FIG. 5, branchlet, × 10, from no. 2676; FIG. 6, fruiting bract, × 4, and FIG. 7, samara, × 4, from no. 2676. FIGS. 8–10, B. MICROPHYLLA Bunge: FIG. 8, fruiting branch, × 1, from the Altai of Siberia, probably an ISOTYPE; FIG. 9, fruiting bract, × 4, and FIG. 10, samara, × 4, from same specimen. FIG. 11, B. ALBA L., var. TORTUOSA (Ledeb.) Schneider: samara, × 4, from Kingua Tunugdliarfik, Greenland, Aug. 17, 1888, *Kolderup Rosenvinge.*

PLATE 964, B. PAPYRIFERA Marsh. (typical): FIG. 1, fruiting branch, × 1, from Middlebury, Vermont, July 8, 1908, *E. F. Williams;* FIG. 2, staminate aments, × 1, from Winchester, Massachusetts, May 9, 1897, *E. F. Williams;* FIG. 3, tip of young shoot, × 5, from Lac Ste.-Anne, Gaspé Co., Quebec, *Victorin, Rolland & Jacques*, no. 33,476; FIG. 4, fruiting bract, × 4, and FIG. 5, samara × 4, from Southport, Maine, Aug. 8, 1894, *Fernald.*

PLATE 965, B. PAPYRIFERA, var. COMMUTATA (Regel) Fernald: FIG. 1, portion, × 1, of the *Lyall* specimen from "Cascade Mountains, 49 N. Lat."; FIG. 2, characteristic close bark, × 1, from Percé, Quebec, July, 1905, *Williams, Collins & Fernald;* FIG. 3, outer bark exfoliating, exposing whitish inner bark, × 1, from base of same tree as in fig. 2; FIGS. 4 and 5, fruiting bracts, × 4, from the *Lyall* specimen; FIG. 6, samara, × 4, from the *Lyall* specimen; FIG. 7, fruiting bract, × 4, from Bayview, Gloucester, Massachusetts, Aug., 1944, *Elizabeth Johnston;* FIG. 8, samara, × 4, from the same specimen as fig. 7.

PLATE 966, B. OCCIDENTALIS Hook., var. FECUNDA Fernald: FIG. 1, portion of TYPE, × 1; FIG. 2, younger (flowering) branchlet, × 1, from type-locality, May 11, 1901, *Piper;* FIG. 3, staminate aments, × 1, from type-locality, April 27, 1925, *Constance et al.*, no. 1043.

PLATE 967, B. PAPYRIFERA, var. PENSILIS Fernald: FIG. 1, portion, × 1, of TYPE; FIG. 2, fruiting bract, × 4, and FIG. 3, samara, × 4, from TYPE; FIG. 4, younger branch, × 1, from Bic, Quebec, July, 1905, *Williams, Collins & Fernald.*

PLATE 968, FIGS. 1–3, B. PAPYRIFERA, var. MACROSTACHYA Fernald: FIG. 1, portion, × 1, of TYPE; FIG. 2, fruiting bract, × 4, and FIG. 3, samara, × 4, from TYPE. FIG. 4, forma LONGIPES Fernald: portion, × 1, of TYPE.

PLATE 969, B. PAPYRIFERA, var. ELOBATA (Fernald) Sargent: FIG. 1, portion, × 1, of TYPE; FIG. 2, immature samara embraced by bract, × 4, from TYPE; FIG. 3, young bracts, × 1, from TYPE.

PLATE 970, B. PAPYRIFERA, var. CORDIFOLIA (Regel) Fernald: FIG. 1, portion, × 1, of fruiting branch from Malbaie, Gaspé Co., Quebec, August 20, 1904, *Collins, Fernald & Pease;* FIG. 2, tip of vigorous sprout, × 5, from Roberval, Quebec, July 28, 1892, *G. G. Kennedy;* FIG. 3, fruiting bract, × 4, and FIG. 4, samara, × 4, from same specimen as fig. 1.

PLATES 971 and 972, B. PAPYRIFERA, var. HUMILIS (Regel) Fernald & Raup. PLATE 971: FIG. 1, portion, × 1, of TYPE of *B. alba* L., subsp. *papyrifera* (Marsh.) Regel, var. *humilis* Regel, with Regel's identification; FIG. 2, lower surface of leaf (with scattered trichomes), × 10, from TYPE; FIG. 3, fruiting bract, × 4, and FIG. 4, samara, × 4, from TYPE; FIG. 5, fruiting tip, × 1, of specimen from Prince Albert, Saskatchewan (*Macoun*, no. 12,952[a]), one of the 2 specimens cited by Sargent as his *B. alaskana.* PLATE 972, FIG. 1, portions,

× 1, of the Saskatchewan plant (*Bourgeau*, 1858), the first specimen cited by its author for *B. alaskana* Sargent: FIG. 2, fruiting bract, × 4, and FIG. 3, samara, × 4, of the Prince Albert material, *Macoun*, no. 12,952[a]; FIG. 4, fruiting bract, × 4, and FIG. 5, samara, × 4, from near Fairbanks, Alaska, *Ynez Mexia*, no. 2291.

PLATE 973, B. BOREALIS Spach: FIG. 1, branches, × 1, from Glenwood, Newfoundland, *Fernald & Wiegand*, no. 5308; FIG. 2, fruiting branch, × 1, from Glenwood, *Fernald & Wiegand*, no. 5309; FIG. 3, tip of young branch, × 5, from no. 5309; FIG. 4, fruiting bract, × 4, and FIG. 5, samara, × 4, from base of Blomidon, Bay of Islands, Newfoundland, *Fernald & Wiegand*, no. 3246.

PLATE 974, FIGS. 1–5, B. UBER (Ashe) Fernald: FIG. 1, portion, × 1, of ISOTYPE in Herb. Arnold Arboretum; FIG. 2, upper surface of leaf, × 2, to show venation and toothing, from ISOTYPE; FIG. 3, portion of lower surface of leaf, × 2, from ISOTYPE; FIG. 4, fruiting bract, × 4, and FIG. 5, samara, × 4, from ISOTYPE. FIGS. 6 and 7, B. LENTA L.: FIG. 6, portion of lower surface of leaf, × 1, to show venation and toothing, from Jamaica Plain, Massachusetts, August 25, 1885, *C. E. Faxon;* FIG. 7, fruiting bract, × 4, from same specimen.

PLATE 975, FIGS. 1–4, B. TERRAE-NOVAE Fernald: FIG. 1, portion of TYPE, × 1: FIG. 2, tip of branchlet, × 5, from Goose Pond, upper Humber River, Newfoundland, *Fernald & Wiegand*, no. 3272; FIG. 3, fruiting bracts, × 10, and FIG. 4, nutlet, × 10, from TYPE. FIGS. 5–7, B. NANA L.: FIG. 5, tip of branchlet, × 5, from Velmunden, Norway, July 23, 1909, *Fr. Lange;* FIG. 6, fruiting bract, × 4, and FIG. 7, samara, × 10, from the *Lange* specimen.

(*To be continued*)

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# A NEW SPECIES OF ANULOCAULIS FROM SOUTHWESTERN TEXAS AND ADJACENT NEW MEXICO

U. T. WATERFALL

SEVERAL collections of *Anulocaulis* were made by the author while botanizing in the Transpecos Region of southwestern Texas and adjacent New Mexico during the summers of 1942 and 1943, and October, 1944. The majority of these were of a plant having large, pallid, eglandular leaves, and long flowers. One collection, my no. 5026 from near the Finlay gypsum quarry in Hudspeth County, was characterized by smaller, greener, papillate-glandular leaves, and by smaller flowers. The latter plant agrees with Torrey's description of *Boerhaavia leiosolena*,[1] the type of which was taken along the Rio Grande about 50 miles southeast of Finlay. The other specimens do not agree with it in several respects.

Most authors have treated the plants as one species, their descriptions merging the characteristics of Torrey's plant with those of later collections which have been almost entirely of the

[1] Torrey, John, *Botany of the Mexican Boundary*, 172. 1859.

proposed new species. The only collections of true *A. leiosolenus* I have seen in the material borrowed from the Gray Herbarium are my no. 5026, mentioned above, and Bigelow's specimen from "the Great Canon of the Rio Grande", presumably near the present location of Indian Hot Springs in southern Hudspeth County. Dr. I. M. Johnston recognized this situation in his account of the *Plants of Coahuila, Eastern Chihuahua, and Adjoining Zacatecas and Durango*[1], citing under *Anulocaulis leiosolenus* only the specimens listed above.

This, the typical variety, *Anulocaulis leiosolenus* (Torr.) Standl., var. **typicus,** nom. nov. (*Boerhaavia leiosolena* Torr., Bot. Mex. Bound. 172. 1859), appears to be a localized plant restricted to gypsum habitats in the southern part of Hudspeth County, while its var. *lasianthus* Jtn. is isolated in the Big Bend[2]. The proposed new species is much wider-ranging, being found on the great Permian gypsum beds of Culberson and Reeves Counties, Texas, in adjacent Eddy County, New Mexico, and as far north as the gypsum deposits of the Comanchean Bluffs east of Roswell, Chaves County, New Mexico. It is an obligate gypsophile, as apparently are other members of the genus.

Anulocaulis **gypsogenus,** n. sp. *Anulocaulis leiosolenus* (Torr.) Standl., Contr. U. S. Nat. Herb. **12.** 375. 1909, *in part.* Not *Boerhaavia leiosolena* Torr. in Bot. Mex. Bound. 172. 1859. —Plant perennial, erect, 8–12 dm. high from a woody root; stems glabrous, usually with an irregular glutinous band on each of the internodes; leaves opposite, mostly from the crowded lower nodes, thus appearing basal; leaf-blades ovate-cordate to reniform-cordate, 7–19 cm. long, 6–23 cm. wide, coriaceous, pallid, glabrous, never glandular-tuberculate as in *A. leiosolenus;* panicle-branches about ⅔ the height of the plant, the ends of the several opposite branches tending to be somewhat closely several-flowered, floral bracts ovate to ovate-lanceolate with acuminate tips; perianths large, about 3–3.5 cm. long, greenish-white suffused with pink toward the limb; lower part of perianth tubular, upper ⅓ funnel-form, 5-lobed, the lobes about 4 mm. long, each lobe deeply bifid and having a prominent midvein extending through the tube to the triangular sinus where it is minutely excurrent; stamens 3, unequal, exserted, 4–6.5 cm. long; bases of filaments unequally united into a short hypogynous tube which is about as long as the ovary; style filiform, extending

[1] Johnston, I. M., *Journ. Arn. Arb.* XXV, 174–175. 1944.
[2] Op. cit. 175.

about 1 cm. beyond the stamens; stigma minutely capitate; anthocarp turbinate, 5–7 mm. long, 4–5 mm. wide, surrounded just below the middle with a reflexed wing about 1 mm. wide, lower part of fruit narrowly conical, upper part hemispherical, prominently 10-ridged.

ANULOCAULIS **gypsogenus,** sp. nov. Planta perennis, e caudice lignoso erecta 8–12 dm. alta; caulibus glabris, internodiis annulo glutinoso irregulari cinctis; foliis oppositis, maxima parte e nodis inferioribus congestis, sicut basalibus: laminis ovato-cordatis vel reniformi-cordatis, 7–19 cm. longis, 6–23 cm. latis, coriaceis, pallidis, glabris, haud glandulari-tuberculatis ut apud *A. leiosolenum;* ramis paniculae pluribus oppositis, apicem versus plus minusve dense plurifloris; bracteis ovatis vel ovato-lanceolatis acuminatis; perianthio magno, ca. 3–3.5 cm. longo, tubo viridi-albido, limbo rosaceo-albido, ca. 1.5 cm. diametro, 5-lobato, lobis ca. 4 mm. longis, bifidis, vena mediana ad imum sinum triangulare inter lobos ca. 3 mm. altum brevissime excurrente; staminibus 3, inaequalibus, exsertis, 4–6 cm. longis, basibus filamentorum in tubum hypogynum ovario subaequilongum inaequaliter adnatis; stylis filiformibus, 5–7.5 cm. longis; stigmatibus minute capitatis; anthocarpiis turbinatis, 5–7 mm. longis, 4–5 mm. diametro, ala angusta reflexa ca. 1 mm. lata infra mediam circumcinctis; parte inferiore fructus anguste conica, parte superiore hemisphaerica, 10-costata.

The TYPE is the author's no. 5701 deposited in the Gray Herbarium. Isotypes are in the Herbarium of the Missouri Botanical Garden, the Herbarium of the New York Botanical Garden, and the author's private herbarium. This collection was taken from gypsum strata on the Comanchean Bluffs on the east side of the Pecos River, 7 miles east of Roswell, Chaves County, New Mexico. Here it grew in association with other gypsophiles characteristic of similar habitats farther south in Transpecos Texas. These include: *Bouteloua breviseta, Sporobolus Nealleyi, Selinocarpus lanceolatus, Mentzelia humilis, Coldenia hispidissima, Gaillardia multiceps, Sartwellia Flaveriae* and *Dicranocarpus parviflorus.*

SPECIMENS EXAMINED: TEXAS, CULBERSON COUNTY: *Cory* 1535, Millers Brothers Ranch (central Culberson Co.), June 17, 1928. REEVES COUNTY: *Waterfall* 4258 from Screw Bean Arroyo near Texas-New Mexico Boundary. COUNTY UNDETERMINED, *Havard* 87 from bluffs of Deleware Creek, West Texas (northern Reeves or Culberson Co.). NEW MEXICO: CHAVES COUNTY: *Waterfall* 4294 from gypsum of Comanchean Bluffs, 7 miles east of Roswell, Aug. 23, 1942; *Waterfall* 5701, TYPE, same site, Oct. 9,

1944. Eddy County: *Strandtman* 6, New Mexico, near Texas State line, Aug. 21, 1941; *Waterfall* 5721 from gypsum hills extending north from the Culberson Plateau, 3 miles north of state line near U. S. Highway 62, Oct. 9, 1944.

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Wynnewood, Oklahoma

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Convolvulus Wallichiana at Swarthmore, Pennsylvania.—Among the plantings around Swarthmore College, Swarthmore, Pa., there grows a species of *Convolvulus* which is rapidly becoming a weed. This plant was first observed about three years ago but little attention was paid to it.

Examination of all keys available failed to establish the identity of this species. It resembles *C. sepium* very closely but is much smaller and the leaf-characters are somewhat different. The specimen was forwarded to the Gray Herbarium where it was identified as *Convolvulus Wallichianus* Spreng., a native of India, China, and adjacent parts of Asia. According to report this is the first specimen collected in America.

The source of this plant at Swarthmore can not be determined with any certainty. It was found growing among some narcissus and near an ilex. The narcissus bulbs came from Germantown, Pa., and much of the shrubbery came from Long Island, N. Y. In addition a great deal of mushroom soil has been added from time to time from New York.

The plant is very difficult to exterminate and is likely to become a nuisance. At present it is found in about five separate areas in and around the buildings.—Samuel C. Palmer, Swarthmore College.

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